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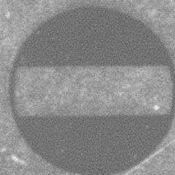THIS PAGE IS UNCLASSIFIED

RIFLE PLATOON
FIREPOWER
EXPERIMENT

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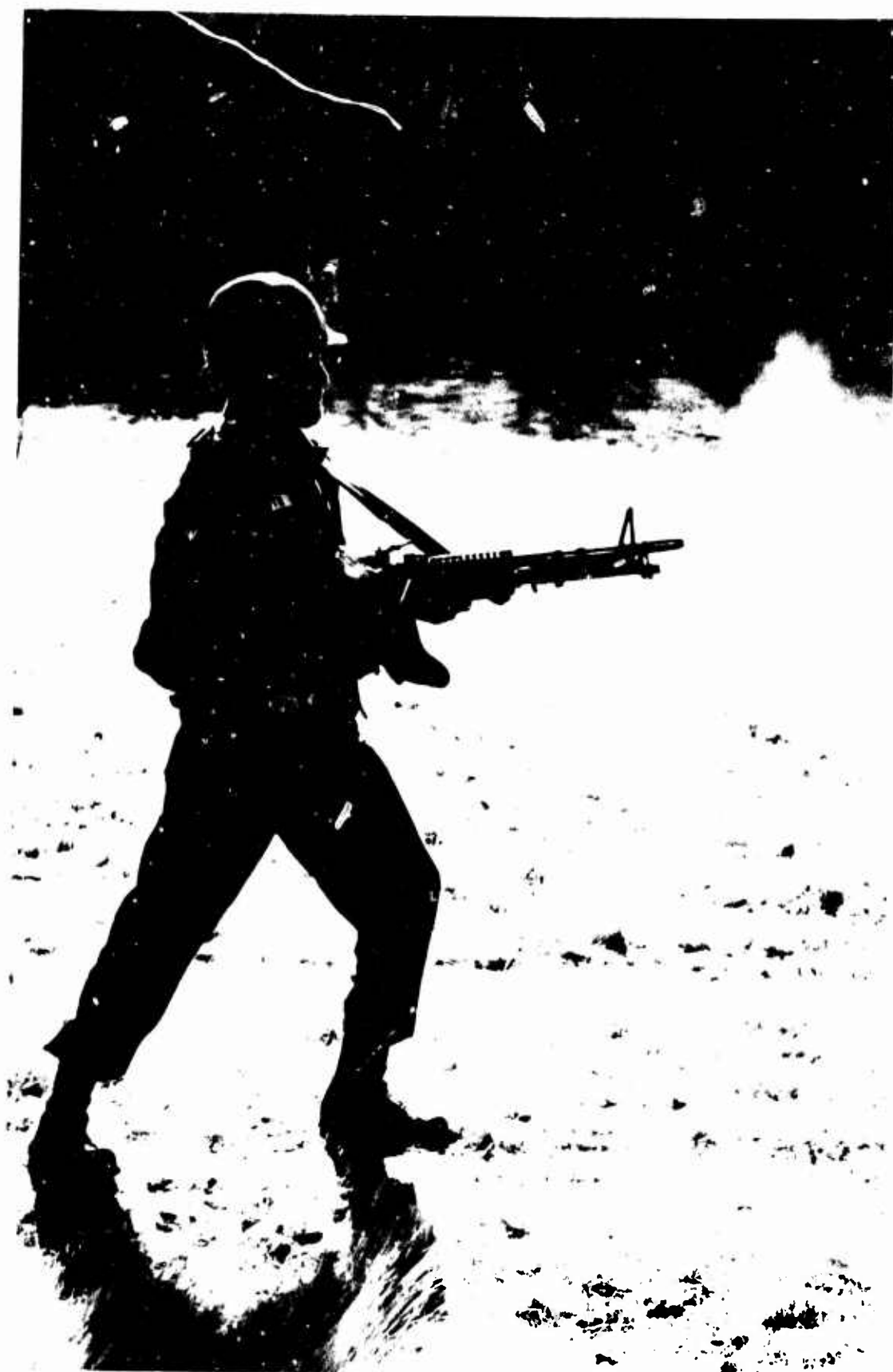### FORT ORD, CALIFORNIA

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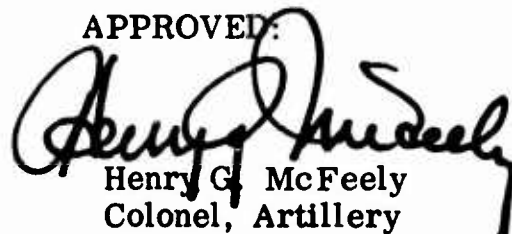~~~~Fort Belvoir Va.~~~~

Headquarters

US ARMY COMBAT DEVELOPMENT EXPERIMENTATION CENTER

Fort Ord, California

RIFLE PLATOON FIREPOWER EXPERIMENT

March 1962

This Final Report Supersedes Letter, ATCDC-CG, Headquarters
USA CDEC, 4 December 1961, Subject: "Memorandum Report of
Firepower Experiment for the Rifle Squad and Platoon" (U), which
is herewith rescinded.

APPROVED:

Henry G. McFeely
Colonel, Artillery
Commanding

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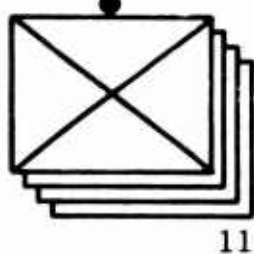
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SUMMARY

1.   The Optimum Composition of the Rifle Squad and Platoon Experiment (Spring 1961) developed an organization intended for use with weapons to be available in 1965-70. The only weapon not now available, however, is the special purpose individual weapon which combines the characteristics of the M14 rifle and the M79 grenade launcher. The purpose of the Rifle Platoon Firepower Experiment was to determine the optimum distribution of current weapons within the rifle platoon from the results of firing various combinations of M14 rifles, M60 machine guns and M79 grenade launchers under simulated battlefield conditions.

2.   From the combined results of both experiments it is recommended that the current rifle squad and platoon be organized as follows:

PLATOON HEADQUARTERS	
Platoon Ldr	Pistol
Platoon Sgt	M79/P
Radio Opr/Msgr	M14

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1 Sqd Ldr	M14
2 Fire Team Ldrs	M14
1 Machine Gnr	M60/P
1 Grenadier/	
Asst Mach Gnr	M79/P
1 Grenadier	M79/P
5 Riflemen	M14

3.   The recommended organization of the mechanized rifle platoon is identical to the above except for the addition of five drivers armed with M14 rifles, one assistant platoon sergeant armed with the M79 grenade launcher and pistol, and five armored personnel carriers.

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I
General Information

1. AUTHORITY

Verbal orders of the Commanding General, US Army Combat Development Experimentation Center.

2. PURPOSE

To determine the optimum distribution of current weapons within the rifle platoon.

3. SCOPE

Information on the most effective distribution by type and numbers of weapons was generated from firing live ammunition by experimental squads in base of fire and assault courses. This experiment was an extension of the Optimum Composition of the Rifle Squad and Platoon Experiment conducted in Spring 1961 (Reference 20, p. 94). The weapons composition within the experimental squads was varied from seven to five M14 rifles. from two M60 machine guns to none, and from one to two M79 grenade launchers. The effect of these variations on volume, effectiveness and distribution of fire was determined. The objectives, or target areas, were instrumented to record the effect and distribution of rifle and machine gun fire and point of burst of grenade rounds. Each squad configuration fired over several tactical courses a sufficient number of times to provide adequate data for statistical analysis.

4. OBJECTIVES

a. To determine the effect of variations in the number of M14 rifles, M79 grenade launchers and M60 machine guns within the rifle squad on volume, effectiveness and distribution of fire.

b. To recommend the optimum rifle squad and platoon organization.

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II
Description of the Experiment

1. GENERAL

a.   The experiment was conducted at Hunter Liggett Military Reservation, California during the period 30 October to 15 December 1961.

b.   As part of a rifle platoon in a series of tactical live firing exercises, each of three experimental squads performed typical assault and base of fire missions.   Supplemental firing tests were also conducted as described in paragraph 5 below.

c.   The experiment did not include night firing, defense situations, or firing at point targets.

2. PERSONNEL AND TRAINING

a.   Personnel for the experimental squads were furnished by the 3d Armored Rifle Battalion, 41st Infantry, USA CDEC.   Prior to the formal training for the experiment, the battalion conducted qualification firing for riflemen and machine gunners.   Personnel were then divided into four groups, each containing an equal number of men from each proficiency category.   Each of the personnel groups contained 14 men which permitted each group to be organized into any of the three experimental squad variations described in paragraph 3, following.   This number of personnel also permitted each run to be conducted with the squad at full strength.   Necessary personnel for control, safety, scoring, recording and target maintenance were furnished by the Umpire Control Group, USA CDEC.

b.   A training program was conducted for personnel of the experimental squads which included: orientation on the experiment; safety; technique of fire of the rifle squad; mechanical weapons training, familiarization firing, zeroing and battlesight of weapons, range familiarization, and live fire practice runs.   In addition, data collection personnel were trained in the use of data collection forms and scoring techniques.

3. EXPERIMENTAL SQUADS

a.   Two of the three squad organizations considered were variations of the optimum organization as developed by USA CDEC in the Optimum Squad and Platoon experiment (Reference 20, p. 94).   The third organization was a rifle squad without machine guns developed by the US Army Infantry School (Reference 22, p. 94).   The organization of these squads is as shown in Figures 1, 2 and 3.

RIFLEMAN

M14 Rifle

RIFLEMAN

M14 Rifle

GRENADIER

M79 Grenade Lchr
Pistol

TEAM LEADER

M14 Rifle

SQUAD LEADER

M14 Rifle

RIFLEMAN

M14 Rifle

RIFLEMAN

M14 Rifle

RIFLEMAN

M14 Rifle

GRENADIER

M79 Grenade Lchr
Pistol

TEAM LEADER

M14 Rifle

FIGURE 1

SQUAD ORGANIZATION ALFA

RIFLEMAN

M14 Rifle

RIFLEMAN

M14 Rifle

GRENADIER

M79 Grenade Lchr
Pistol

RIFLEMAN

M14 Rifle

RIFLEMAN/ASST MG GNR

M14 Rifle

RIFLEMAN

M14 Rifle

MACHINE GUNNER

M60 Machine Gun
Pistol

GRENADIER

M79 Grenade Lchr
Pistol

TEAM LEADER

M14 Rifle

TEAM LEADER

M14 Rifle

SQUAD LEADER

M14 Rifle

FIGURE 2

SQUAD ORGANIZATION BRAVO

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RIFLEMAN
M14 Rifle

RIFLEMAN
M14 Rifle

RIFLEMAN
M14 Rifle

GRENADIER
M79 Grenade Lchr
Pistol

RIFLEMAN/ASST MG GNR
M14 Rifle

RIFLEMAN/ASST MG GNR
M14 Rifle

MACHINE GUNNER
M60 Machine Gun
Pistol

MACHINE GUNNER
M60 Machine Gun
Pistol

TEAM LEADER
M14 Rifle

TEAM LEADER
M14 Rifle

SQUAD LEADER
M14 Rifle

FIGURE 3
SQUAD ORGANIZATION CHARLIE

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(1) <u>Squad A (ALFA)</u> consisted of 10 men organized with a squad leader, squad sergeant, squad corporal, five riflemen and two grenadiers. All squad members were armed with the M14 rifle except the two grenadiers who were armed with the M79 grenade launcher and M1911A1 pistol.

(2) <u>Squad B (BRAVO)</u> was a squad with one machine gun. It consisted of 11 men organized with a squad leader and two 5-man fire teams. Alfa team had a team leader, machine gunner, rifleman/assistant machine gunner, grenadier and a rifleman. Bravo team had a team leader, grenadier and three riflemen. The machine gunner was armed with the M60 machine gun and M1911A1 pistol. The grenadiers were armed with the M79 grenade launcher and M1911A1 pistol. All other squad members were armed with the M14 rifle.

(3) <u>Squad C (CHARLIE)</u> is a squad with two machine guns. It consisted of 11 men organized with a squad leader and two 5-man fire teams. One team consisted of a team leader, machine gunner, rifleman/ assistant machine gunner, and two riflemen. The other team had a team leader, machine gunner, rifleman/assistant machine gunner, grenadier and one rifleman. Machine gunners were armed with the M60 machine gun and M1911A1 pistol. The grenadier was armed with the M79 grenade launcher and M1911A1 pistol. All other squad members were armed with the M14 rifle.

b. The organization developed in the prior CDEC experiment was based on the use of materiel to be available in 1965-70. The only weapon not in current production, however, is the special purpose individual weapon (SPIW)*, which combines the capabilities of the M14 rifle and M79 grenade launcher. Accordingly, this recommended organization is considered suitable for immediate adoption by substituting an appropriate combination of the M14 and M79 for the SPIW in the Infantry squad. The present experiment assisted in determining this combination and in addition looked further into the advisability of one or two machine guns per rifle squad.

4. TACTICAL SITUATIONS

a. The environment for the firing courses was that of a rifle platoon in the attack. The platoon leader receives a mission to capture an objective, a terrain feature. His decision is to assign one squad, or squad reinforced, to place fire on the objective while he maneuvers the remainder of the platoon to an assault position and assaults the objective. Enroute to the objective he decides to form a second base of fire at a closer range and makes the final assault with the remainder of the platoon.

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* Formerly called all purpose handheld weapon (APHHW).

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To represent this type situation one base of fire Course I was established at a range of 400 meters from the objective, Course II at 250 meters range, and two assault courses, III and IV, were prepared. (See Figures 4 & 5.) To permit an accurate differentiation of fire effects from each element, all courses were physically separated and operated independently.

b. Squads in the base of fire were required to maintain their fire for a specified length of time representing the time required for a maneuver element to reach the assault line. This time was eight minutes for the 400-meter course and five minutes for the 250-meter course. No time limit was imposed on the assault phase which began at 125 meters and halted at 50 meters from the objective. The squads were required to employ marching fire and the elapsed time for each run was recorded. These runs were generally of two or three minutes' duration. Squads in the assault role ceased firing and halted 50 meters from the objective for safety reasons and to prevent personnel from firing at point blank range. Hits obtained at minimum ranges would not reflect accurately the ability of a unit to distribute effective fire on the objective throughout the duration of the assault.

c. The weapons and ammunition available to the experimental squads are summarized in Tables 1 and 2. Although each squad nominally had eight rifles, in all squads the squad leader did not fire except for three rounds to mark the objective in the base of fire courses. In the base of fire tests the rifleman/assistant machine gunners in BRAVO and CHARLIE squads were fully occupied in the latter role, thus effectively reducing the number of rifles in these squads to six and five, respectively. Tables 1 and 2 indicate the ammunition allowances for each squad variation and for each squad member in both the base of fire and assault.

d. Each of the three squad configurations fired 20 runs on each of the two assault and base of fire courses, a total of 240 runs.

e. When in the base of fire roles, the ALFA squad would normally be reinforced by the attachment of one or more machine guns from the weapons squad. If the weapons squad contains three machine guns, various combinations of attachments to base of fire and assault squads are possible. These various combinations were not fired in this experiment, but the results may be approximated from the data presented in this report. For example, when one machine gun is attached to the ALFA squad the squad is the equivalent of the BRAVO squad in the assault and of the BRAVO squad with an additional M14 rifle in the base of fire.

f. The M79 grenade launcher was fired separately from the rifles and machine guns. In the base of fire the launcher was fired from 300 meters and 200 meters at a hillside target area 200 meters wide and 40-50 meters deep. The grenadiers were given eight rounds each at

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TABLE 1

WEAPONS AND BASIC LOADS PER SQUAD

Squad	Mission	M14 Rifle		M60 Machine Gun		M79 Grenade Launcher	
		Nr Wpns	Rounds	Nr Wpns	Rounds	Nr Wpns	Rounds
ALFA	Base of Fire	7	700	-	-	2	16
	Assault	7	700	-	-	2	10
BRAVO	Base of Fire	7*	600	1	300	2	16
	Assault	7	700	1	200	2	10
CHARLIE	Base of Fire	7*	500	2	600	1	8
	Assault	7	700	2	400	1	5

* See sub-para c, above.

TABLE 2

BASIC LOAD PER SQUAD MEMBER

Squad Member	Mission	Rounds
Squad Leader	Base of Fire	3 rounds (for designating right limit, center and left l'.. it of target area)
	Assault	None (Primarily concerned with controlling his squad)
Team Leader	Base of Fire	100 rounds in 5 magazines
	Assault	100 rounds in 5 magazines
Machine Gunner	Base of Fire	300 rounds in 3 metal link belts
	Assault	200 rounds in 2 metal link belts
Rifleman/Ass't Machine Gunner	Base of Fire	None (Primary duty was to assist machine gunner)
	Assault	100 rounds in 5 magazines
Rifleman	Base of Fire	100 rounds in 5 magazines
	Assault	100 rounds in 5 magazines
Grenadier	Base of Fire	8 rounds
	Assault	5 rounds

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these two ranges and instructed to deliver uniform fire on the target area. Fire was also to be distributed over time, eight minutes at 300 meters, and five minutes at 200 meters.

g. The M79 grenade launcher was tested in the assault fire role on two ranges, with no time limit imposed in either case. In the first test, each of four grenadiers fired five rounds into an open target area 100 meters by about 50 meters while advancing from a distance of 125 meters to 50 meters from the target area. During this test the point of burst of each round was recorded. In the second test, each of four grenadiers fired five rounds into an area approximately 50 meters by 35 meters, starting at a range of 125 meters and halting at 60 meters from the target area. The targets on this range, which was in a wooded area, were three dimensional so that the effect in terms of number of targets hit by both ground and tree bursts could be measured.

5. SUPPLEMENTAL EXPERIMENTATION

Additional tests were conducted with the M60 machine gun, M14 (Modified) rifle, and M79 grenade launcher as follows:

a. M60 with Bipod and Tripod Mounts

To obtain a comparison of fire effect and distribution between the bipod mounted gun and the tripod mounted gun, six runs with two machine guns on tripod mounts were conducted on Course I at a range of 400 meters. Each gunner was issued 300 rounds of ammunition per run. Six runs with two machine guns on tripod mounts and two runs with two machine guns on bipod mounts were conducted on Course I at a range of 850 meters. Each gunner was issued 600 rounds of ammunition per run. (See Figure 7.)

b. M14 (Modified)

To determine the advantage, if any, of arming riflemen with the M14 (Modified) rifle, six runs with the rifles of the A squad variation fired on full-automatic were conducted on Course III starting at 88 meters and halting 50 meters from the objective. Each rifleman was issued 50 rounds of ammunition.

c. M79 with Observer

Due to the difficulties of some M79 grenadiers in sensing a round, a test was conducted in a non-tactical environment to determine if an observer 40 meters to one flank would significantly increase the gunner's ability to hit a target. Sixteen runs were made, eight with an observer and eight without an observer. The gunner fired first at four pop-up targets at varying ranges unaided, then he fired the same course

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with the assistance of an observer who communicated by arm signal. At each target the gunner fired five rounds. Each burst was plotted and distance from target measured and recorded.

d. M79, Rate and Accuracy of Fire

To obtain information on rate and accuracy of fire with the M79 grenade launcher, eight runs were conducted on an assault course where the gunner was issued 15 rounds of ammunition and was instructed to fire at three aperture (window frame) type targets as accurately and as rapidly as possible. The first target was fired at from a stationary sand-bagged position. The other two targets were fired on as the gunner moved forward. (Figure 6)

e. M79 in Wooded Areas

To determine the effect of M79 grenade launcher fire in densely wooded areas where the possibility of tree bursts was high, 12 runs were conducted, each of three gunners firing four rounds at two wooded target areas at a range of 200 meters and then again at 300 meters. Each target area was instrumented with "E" type silhouettes laid flat so that the effect of the tree bursts could be measured (see Figure 6).

6. FIRING COURSES

a. Seven tactical firing courses were established to conduct the various tests described in the preceding paragraphs. As mentioned previously, base of fire and assault missions were fired concurrently on separate courses. The M79 grenade launcher was not fired in conjunction with rifles and machine guns to preclude destruction of silhouette targets containing rifle and machine gun hits.

b. The experimental squads were trained to distribute their fire laterally and in depth over the entire target area. The targets, concealed with trees, brush, and paint and generally hidden from view, served as hit recorders and not as targets at which fire was aimed. Targets were used to measure, by hits recorded, the distribution actually achieved in both time and area coverage. The target areas were selected to provide depth as well as a linear front and varied from lightly to moderately wooded. All were instrumented with "E" and "F" type silhouette targets in the numbers shown in Table 3, below. (See also Figure 8.)

c. Table 3, following presents a summary description of the firing courses and their respective uses. Annex B (p. 71) depicts the firing courses and the emplacement of targets within the target areas.

TABLE 3

SUMMARY OF FIRING COURSES AND SITUATIONS

Course	Weapon(s)	Situation or Test	Nr of Runs	Firing Range (meters)	Target Area Height* (meters)	Target Area Width (meters)	Target Area Area (sq meters)	Hit Recorders Nr	Hit Recorders Coverage (sq meters)
I	M14 & M60	Base of Fire	20 per Sqd Organization	400	13	200	2600	160	67.4
II	"	"	"	250	30.8	100	3080	160	67.4
III	"	Assault	"	125-50	11.9	100	1190	150	56.9
IV	"	"	"	125-50	11.3	80	904	152	57.9
V	M79	With & Without Observer	16	121, 197, 254, 357				4 Pop-up targets Type E	
VI	M79	Effectiveness in Wooded Area	12	200 & 300				4,547	
VII	M79	Base of Fire Assault	8 4	200 & 300 125-50		200 100		(Burst points marked)	
I	M60	Tripod Mount " Bipod Mount	6 6 2	400 850 850	13	200	2600	150	67.4
III	M14 (Mod)	Full Automatic Fire-Assault	6	88-50	11.9	100	1190	150	56.9
VII	M79	Rate and Accuracy of Fire	8	120-100				3 Targets (window frame) Approx 2' x 3'	
II	M79	Assault	4	125-60	11.9	50	595	75	28.5

* Projected mean vertical height. See Figure B-3, p. 75.

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FIGURE 4
BASE OF FIRE

Upper photo shows Course II, where base of fire missions were conducted at 250 meter range Target area is wooded ridge shown mid-center.

View of portion of base of fire is shown at left.

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FIGURE 5
ASSAULT

Dust rises in target area of assault Course IV (top) from fire of advancing rifle squad (lower photo). Assault began at 125-meter range, ended at cease-fire line (marked by tape in foreground of upper photo) 50 meters from forward edge of target area.

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FIGURE 6

M79 GRENADE LAUNCHER

In addition to base of fire and assault exercises, supplemental studies were made with the grenade launcher.

Rate and accuracy of fire were tested by firing at point targets, first from a sand-bagged position, and then while moving forward (left page). The effectiveness of the weapon in wooded areas was tested on a firing course closely overlaid with targets which registered tree burst patterns (above).

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FIGURE 7
MACHINE GUN

In addition to assessment of the M60's contribution to squad firepower on the base of fire and assault courses, a supplemental test was made to compare results with the tripod mount (above) and the integral bipod mount (left).

FIGURE 8
HIT RECORDING

Close-up of hillside target area (large photo below) shows placement of silhouette targets used to register hits, although underbrush screened these from view of firers below. Hits were counted by enumerators (inset) who moved in after each run.

(Above) A number of targets on each base of fire course were wired to Esterline-Angus recorders to provide information as to time-distribution of hits.

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III
Evaluation Plan

1. DESIGN CONSIDERATIONS

a. The primary focus of this experiment was on a single independent controllable variable -- namely, the weapons mix of the infantry squad. The experiment was designed to provide an evaluation of three squad organizations employing different weapon mixes of the M14 rifle, the M14 (Mod), rifle, the M60 machine gun, and the M79 grenade launcher, in the selected tactical context. Supplementary data were also obtained in separate firings. (See Table 3, p. 11, for summary of courses and situations.)

b. The analysis required accurate differentiation between hits made by rifle fire and those made by machine gun fire. Preparation time for the experiment did not permit acquisition and use of electronic equipment for this purpose. Testing with color-coded ammunition as an alternative means of providing the required hit differentiation was inconclusive and not used. The procedure employed to meet the design requirement was that of split runs; that is, making each run twice, firing rifles and machine guns separately and recording the results of the fires of each type of weapon. The rifle and machine gun results were then combined to derive the overall squad result for each run. In this manner, the contribution to the overall squad result made by each type weapon was accurately identified. There remained, however, the possibility that the split-run technique would not take into account any interaction process that might exist when rifles and machine guns fire simultaneously and that such interaction would be variable depending upon the particular weapons composition of the squad. To the extent that such interaction normally would be a factor, the split runs would produce biased results. Accordingly, a number of control runs were included in the experimental design in which all rifles and machine guns in the squad were fired simultaneously. Comparison of the results of these control runs with those of the split runs provide a test of the validity of the procedure adopted.

c. The M79 grenade is qualitatively different from that of the small arms rounds in its effect. Data on the grenade rounds were therefore collected primarily by measuring the points of burst from the target and not by recording the effect of the round upon the target. The exception was a limited number of runs conducted on assault Course III where data were collected on number of targets hit.

d. The experimental design included several means to balance extraneous confounding variables which could neither be eliminated nor experimentally controlled. The sequence of variations was such that the squad organizations were employed an equal number of times in morning

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and afternoon runs during the experiment. This measure assured that all experimental units were exposed in equal degree to cyclic changes in temperature, light and human efficiency during the day. The learning factor associated with the continued repetition of the same run was held to a minimum by the use of two experimentation units for each of the squad roles, their rotation between ranges, equalization of runs among the squad organizations on each range, and finally the rotation of fire team positions within the squad organizations for successive runs over the same course.

2. INSTRUMENTATION OF THE COURSES

a. The type of squad fire normally employed in the situations prescribed by this experiment is area or neutralizing fire, that is, fire distributed over and intended to cover the objective. The purpose of the squad in the base of fire is to neutralize the enemy position to permit the maneuver element to move into an assault position. In the assault "Riflemen move rapidly... firing aimed or well directed shots...at enemy locations in their zone of advance that could conceivably contain an enemy ...this phase of the assault is characterized by volume and accuracy of fire and violence of action." (FM 7-11, Infantry, Airborne Infantry, and Mechanized Infantry Rifle Company, p. 69, Final Manuscript, September 1961).

b. The criteria of evaluation consist essentially of the number and distribution of hits delivered on the objective, rather than the accuracy of fire against point type targets, for example. Accordingly, what was required was a system of collecting hits delivered anywhere on the objective. It was not practicable to cover the entire objective with hit collectors or recorders but a sufficient number were placed on the objective to insure enough hits to measure differences. Standard E and F silhouette targets were used to record hits. These targets had no tactical significance. They represented hit collectors and served as a mechanical means of recording hits. On each range, the target area was camouflaged in order to conceal these hit collectors from the firing line.

c. The numbers of hit recorders emplaced on the various firing courses are listed in Table 3 (p. 11). They were calculated on the basis of E and F target sizes relative to target area and the number of rounds expected to be fired.

d. In order to insure as even coverage of the objectives as the physical features of each course permitted, the hit indicators were emplaced as uniformly as terrain permitted, rather than in a random fashion. Half of the indicators on each of the base of fire courses were wired in order to provide an automatic record of the time of the hits on these selected uniformly distributed indicators. Hits on these targets actuated

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micro-switches which were wired to Esterline-Angus pen recorders, providing an automatic record on a time interval tape.

3. TYPES AND SOURCES OF DATA

Two kinds of data were collected: firing data obtained at the firing source, and hit data obtained from hit indicators emplaced on the objectives. For the different type weapons, these are as follows:

a. Rifle and MG Firing Data: These data consist of the number of rounds fired from each weapon of the squad.

b. Rifle and MG Hit Data: The hit data are the record of the number of hits on each indicator. This record was obtained manually by a team of scorers assigned to each course. For the base of fire courses only, the time distribution of hits on the objective was recorded.

c. M79 Data: These data provide information on the distribution and degree of target area coverage effected by a specified number of rounds fired in both the base of fire and assault situations. Additionally, several supplemental experiments provided data on the rate and accuracy of fire of the M79, on differences in the sensing of hits and the accuracy of fire when firing with and without a lateral observer, and on the problem of firing at targets masked by trees.

d. Other Rifle and MG Data: In addition to the above, a limited number of runs were made with the ALFA organization firing the M14 (Mod) fully automatic on a shortened assault range, moving from a line approximately 88 meters from the objective to the cease fire line 50 meters short of the objective. The same firing and hit data were collected to provide information on the distribution and accuracy of fire. A limited number of runs were also made firing the M60 machine gun mounted on the M122 tripod at ranges of 400 meters and 850 meters on one of the base of fire courses, making it possible to compare the distribution of fire obtained with the tripod mount with that obtained when using the integral bipod mount.

4. PLAN OF ANALYSIS

a. The dependent or criterion variables which were considered in the analysis (Annex C) are:

(1) The total number of hits recorded. This has been treated statistically in both absolute terms and as ratios of the number of rounds fired and the number of weapons firing.

(2) The number of targets hit. This has also been treated

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in both absolute terms and as ratios of the number of rounds fired, number of rounds fired, number and/or type of weapons firing, and total number of hits.

        (3)   The distribution of hits over the target area.

        (4)   The time distribution of hits over the period of the run. This applies to the base of fire courses only and is a measure of the ability of the squad to maintain a constant neutralizing fire on the objective.

    b.   The primary task of the analysis was to determine whether there were any differences among the squad organizations in their fires in the assault and base of fire roles as measured above and to determine whether any such differences are statistically significant. To do this, each of the dependent variables described above was examined individually as a function of the independent variable, the squad organizations. Performance on each of the four courses was examined independently, inasmuch as the differences among the courses were such as to preclude direct comparisons. Where the data did not permit statistical treatment, descriptive measures have been drawn and presented. The M79 firing provides the points of burst extended to indicate coverage of the target area, based on the known lethality radius of the round.

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IV
Results of Experimentation

1. INTRODUCTION

This section first presents the findings with respect to the three mixes of M14 and M60 machine guns represented by the three experimental squad organizations. The data for the base of fire and assault courses are summarized in the following terms:

    a.   Number of rounds fired (volume of fire).

    b.   Number of hits (effectiveness of fire).

    c.   Number of targets hit (distribution of fire).

    d.   Ratio of hits, and targets hit, to number of rounds fired (efficiency of the weapons).

    e.   Distribution of hits over target area.

    f.   Distribution of hits over time (base of fire data only).

Succeeding paragraphs in this section present summarized data and findings for the separate firings of the M79 grenade launcher, as well as for several supplemental tests concerning the M14 (mod) rifle and the M60 machine gun mount.

2. FINDINGS, BASE OF FIRE COURSES (Table 4, following)

    a.   <u>M14 Rifle</u>

        (1) As shown in Table 4, the number of rounds fired decreased proportionally with the decrease in the number of rifles at both the 400 and 250-meter ranges. Each organization fired about 97% of its basic load.

        (2) The number of hits and the number of targets hit generally decrease proportionately with the decrease in the number of rifles (Figure 9 below). However, the number of hits per round fired (hit probability) and the number of targets hit per round fired (hit distribution) increased as the number of rifles in the squad were decreased (Figure 10 below).

    b.   <u>M60 Machine Gun</u>

        (1) A comparison of one machine gun vs two machine guns on the base of fire ranges shows an equivalence in the number of rounds fired

TABLE 4 SUMMARY OF FIRING DATA

Base of Fire Courses

Squad Organ (Nr Wpns)	Basic Load (Rds)	Rds Fired		Hits		Tgts Hit		Hits/Rds Fired		Tgts Hit/ Rds Fired	
		400*	250*	400*	250*	400*	250*	400*	250*	400*	250*
M14 Rifle											
ALFA (7)	700	677	672	28.1	32.8	20.6	23.1	.0415	.0489	.0304	.0343
BRAVO (6)	600	584	579	24.5	29.9	18.1	22.5	.0419	.0517	.0309	.0387
CHARLIE (5)	500	486	481	21.5	26.3	16.3	18.6	.0442	.0547	.0336	.0385
M60 Machine Gun											
ALFA (0)	---	---	---	----	----	----	----	----	----	----	----
BRAVO (1)	300	298	291	10.3	15.9	9.1	12.2	.0344	.0544	.0304	.0417
CHARLIE (2)	600	585	591	19.8	24.5	14.5	18.4	.0338	.0415	.0248	.0311
M14 Rifle + M60 Machine Gun											
ALFA	700	677	672	28.1	32.8	20.6	23.1	.0415	.0489	.0304	.0343
BRAVO	900	882	870	34.8	45.8	27.2	34.7	.0394	.0526	.0308	.0399
CHARLIE	1100	1071	1072	41.3	50.8	30.8	37.0	.0386	.0474	.0288	.0345

* Range from firing line to target area in meters.

Note: Numbers are averages per run. Those in last block (M14 + M60) are combined data for separate runs of rifles and machine guns (except for ALFA which has rifles only).
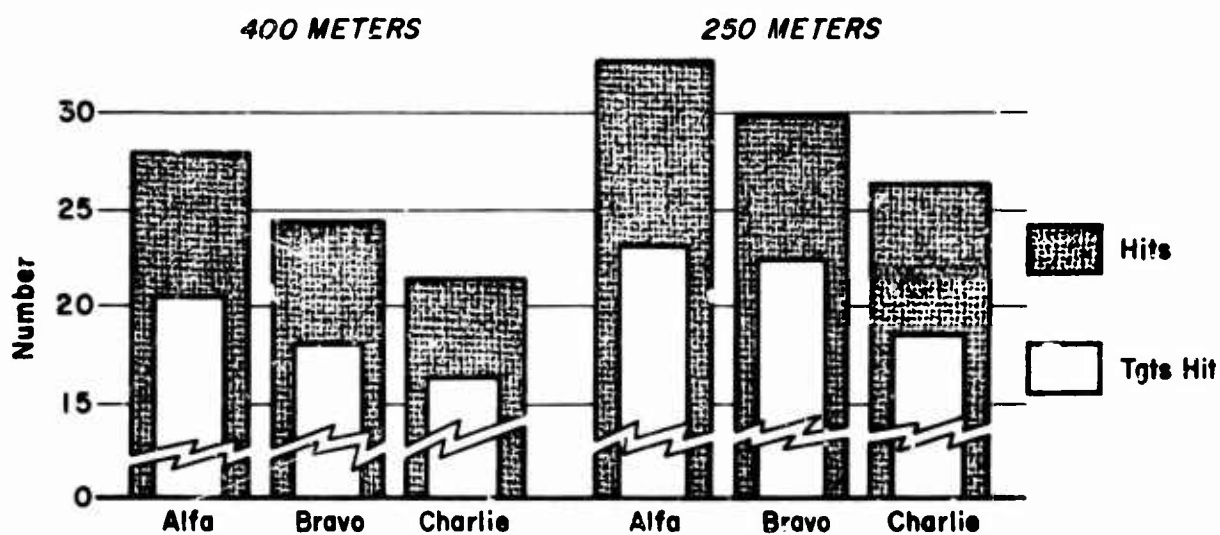
24

FIGURE 9 HITS AND TARGETS HIT
M14 Rifles – Base of Fire Courses
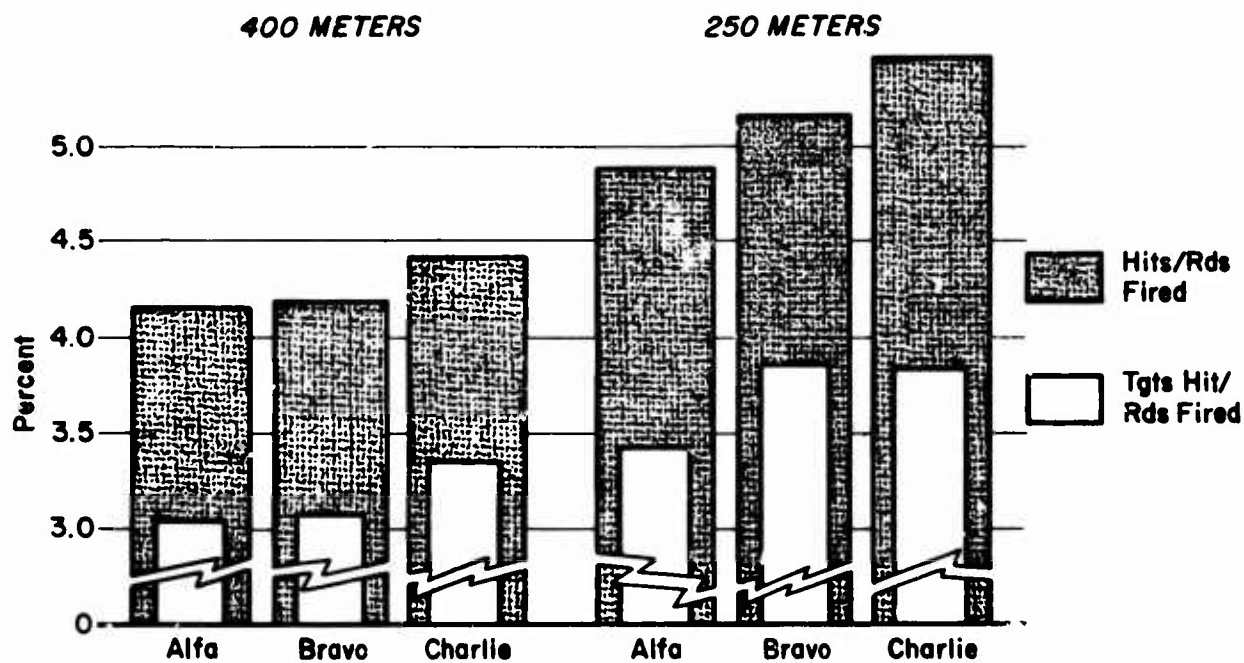(Average per Run)

FIGURE 10 HITS/ROUNDS FIRED AND TARGETS HIT/ROUNDS FIRED
M14 Rifles – Base of Fire Courses
(Average per Run in Percent)

Note: In Figures 9 and 10 above, Alfa = 7 rifles, Bravo = 6 rifles,
Charlie = 5 rifles.

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(about 295 rounds) per machine gun at both the 400 and 250 meter ranges.

(2) Figure 11 oposite shows CHARLIE squad with two machine guns had a greater number of hits and targets hit than the BRAVO squad organization with one machine gun. CHARLIE squad's percentage increase over the BRAVO squad was greater at 400 meters than at 250 meters, though the total numbers of hits and targets hit were greater at the shorter range.

(3) The number of hits, and number of targets hit, per round fired with the M60 machine guns on the base of fire ranges decreased when two machine guns were firing (Figure 12).

c. M14 Rifle and M60 Machine Gun

(1) The BRAVO squad with six M14 rifles and one M60 machine gun, on the base of fire ranges, increased the average number of rounds fired per run (as compared to ALFA squad), increased the number of hits, increased the number of targets hit, and increased somewhat the number of targets hit per round fired. (See Figure 15, p. 31). There was also an increase in the number of hits per round fired at 250 meters, but a slight decrease in this measure for the 400-meter range.

(2) Again on the base of fire courses, the CHARLIE squad with five M14 rifles and two M60 machine guns increased by a greater amount than BRAVO the average number of rounds fired per run (as compared with ALFA squad), increased the number of hits and number of targets hit but decreased the number of hits per round fired, and targets hit per round fired.

(3) In terms of hits and targets hit, two machine guns in the squad were not twice as effective as one.

(4) The difference in number of hits per round fired and targets hit per round fired noted in the foregoing paragraphs are not highly significant statistically. That is, based on tests for statistical significance alone the probabilities are not high that the apparent differences reflect real differences among the squad organizations rather than differences resulting from sampling error. However, these results are internally consistent with comparable results noted in the assault course data, in which the differences are statistically significant. This evidence indicates, although not conclusively, that as the numbers of rifles and machine guns are increased, the ratios of hits and targets hit to rounds fired decrease.
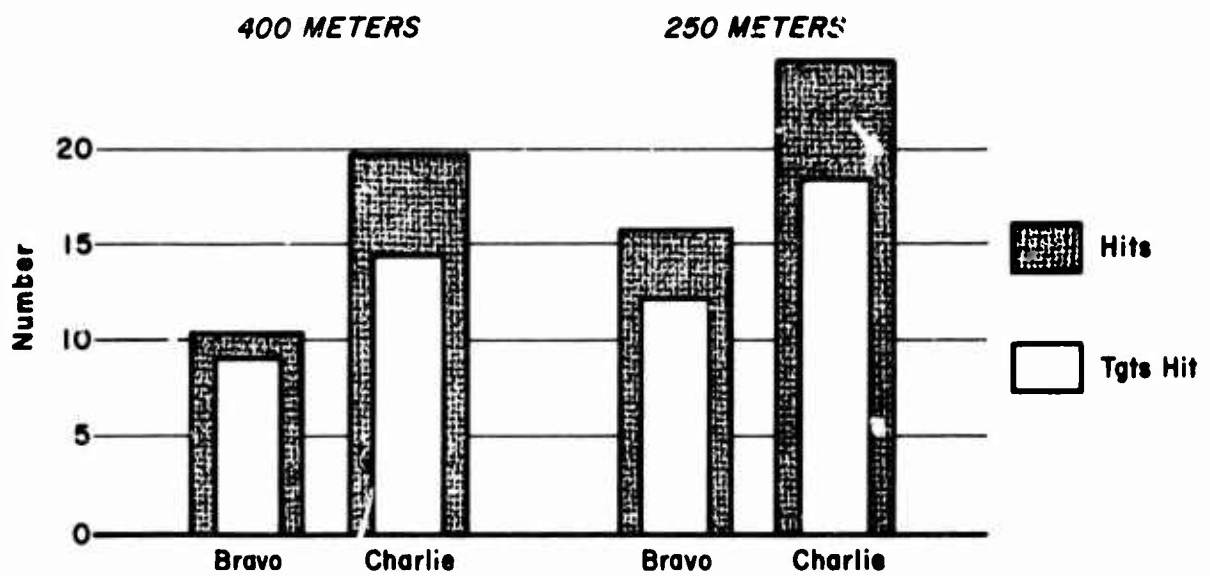
FIGURE 11 HITS AND TARGETS HIT
M60 Machine Guns - Base of Fire Courses
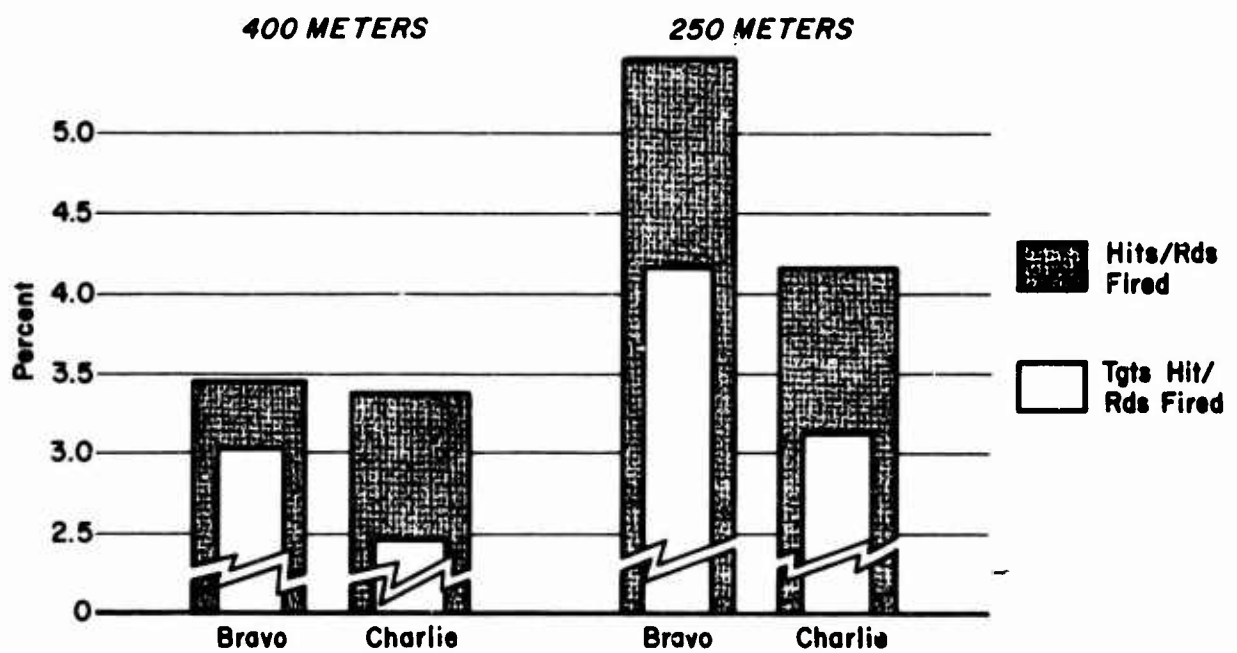(Average per Run)

FIGURE 12 HITS/ROUNDS FIRED AND TARGETS HIT/ROUNDS FIRED
M60 Machine Guns - Base of Fire Courses
(Average per Run)
Note: In Figures 11 and 12 above, Bravo = 1 MG, Charlie = 2 MG.

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3. FINDINGS, ASSAULT COURSES (Table 5, following)

   a. M14 Rifle

   As shown by the table (and as might be expected since the number of rifles was the same for all squads), there were essentially no differences among the results of the M14 rifle fire of the three organizations on the assault ranges.

   b. M60 Machine Gun

   (1) A comparison of one machine gun (BRAVO) vs two machine guns (CHARLIE) on the two assault courses indicates that about the same number of rounds (about 197) were fired per machine gun in each squad organization.

   (2) The CHARLIE squad with two machine guns increased the average number of hits per run and the number of targets hit (see Figure 13 below) over the BRAVO squad with one machine gun. However, the two machine guns showed a drop in number of hits per round fired and targets hit per round fired (see Figure 14 below). These figures are statistically significant and again indicate that two machine guns are not twice as effective as one.

   c. M14 Rifle and M60 Machine Gun

   (1) The bottom block of Table 5 shows the combined scores for the M14 rifles and M60 machine guns of BRAVO and CHARLIE squads on the two assault courses. As compared to the ALFA squad's performance with rifles only, the BRAVO squad with seven M14 rifles and one M60 increased the average number of rounds fired per run, increased the number of hits, and increased the number of targets hit per run; while the number of hits per rounds fired showed a decrease, the number of targets hit per rounds fired remained about the same.

   (2) The CHARLIE squad with seven rifles and two machine guns showed a further increase in the average number of rounds fired per run, the number of hits, and number of targets hit, but shows a decrease in hits per round fired and targets hit per round fired (see Figure 15). These differences are statistically significant.

   (3) These data confirm the trend noted in the base of fire data that as the number of machine guns is increased the ratios of hits and targets hit to round fired decreases.

TABLE 5   SUMMARY OF FIRING DATA
Assault Fire Courses

Squad Organ (Nr Wpns)	Basic Load (Rds)	Rds Fired	Hits	Tgts Hit	Hits/Rds Fired	Tgts Hit/Rds Fired
M14 Rifle						
ALFA (7)	700	523	66.5	41.5	.1272	.0795
BRAVO (7)	700	516	67.8	42.1	.1305	.0815
CHARLIE (7)	700	509	63.5	40.0	.1248	.0787
M60 Machine Gun						
ALFA (0)	---	---	---	---	---	---
BRAVO (1)	200	198	20.9	15.6	.1055	.0786
CHARLIE (2)	400	392	32.4	23.6	.0828	.0602
M14 Rifle + M60 Machine Gun						
ALFA	700	523	66.5	41.5	.1272	.0795
BRAVO	900	714	88.7	57.7	.1242	.0800
CHARLIE	1100	901	95.9	63.6	.1064	.0706

Note: Numbers are averages per run based on 20 runs. Those shown in last block (M14 + M60) are combined data for separate runs of rifles and machine guns (except for ALFA, which has rifles only).
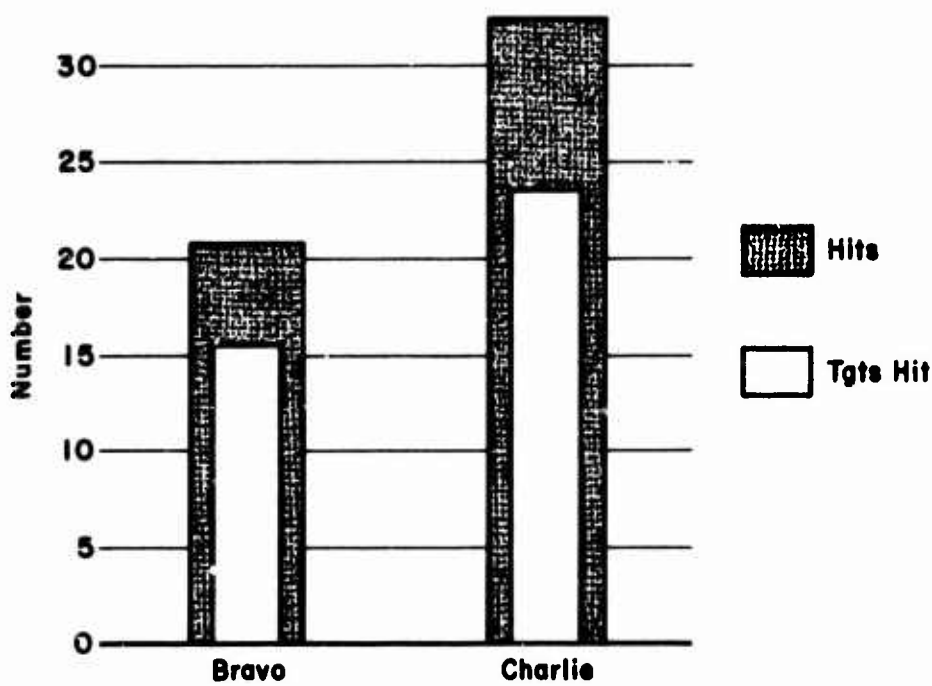
29

FIGURE 13 HITS AND TARGETS HIT

M60 Machine Guns - Assault Fire Courses
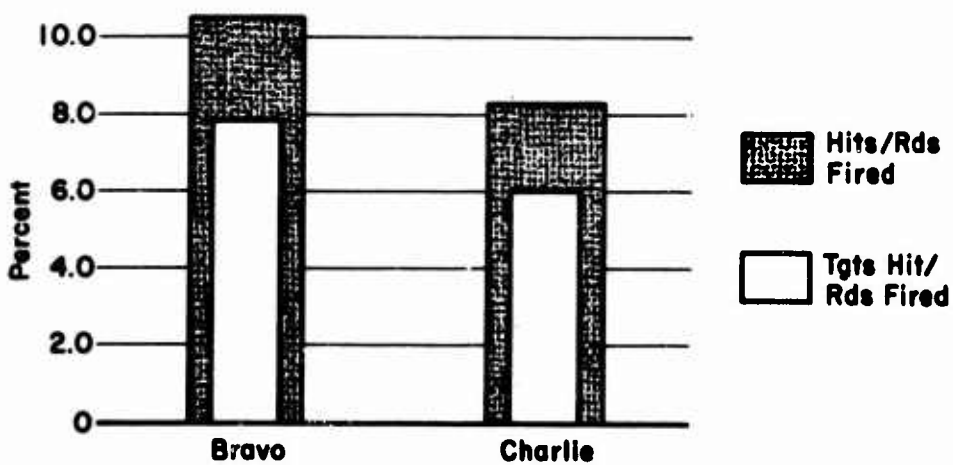
(Average per Run)

FIGURE 14 HITS/ROUNDS FIRED AND TARGETS HIT/ROUNDS FIRED

M60 Machine Guns - Assault Fire Courses

(Average per Run)

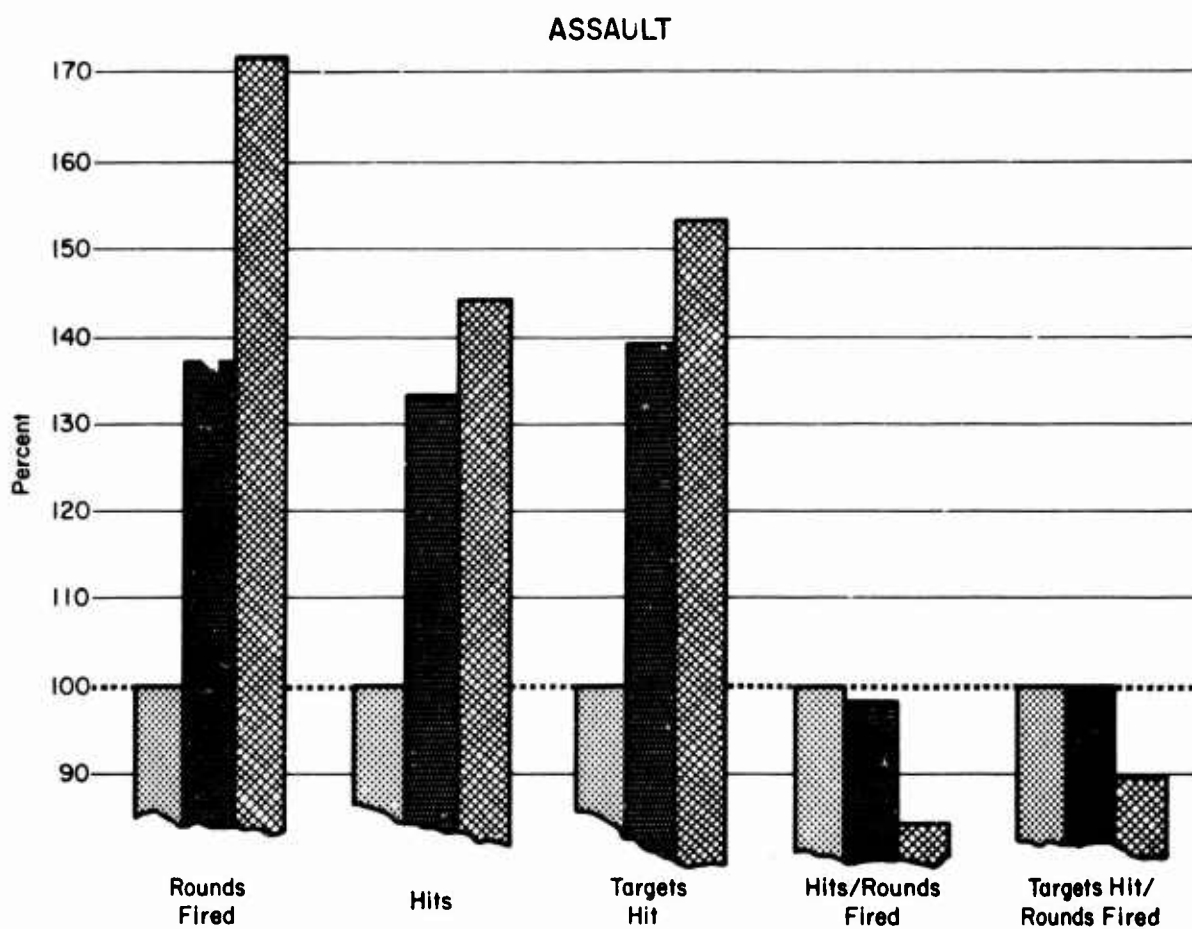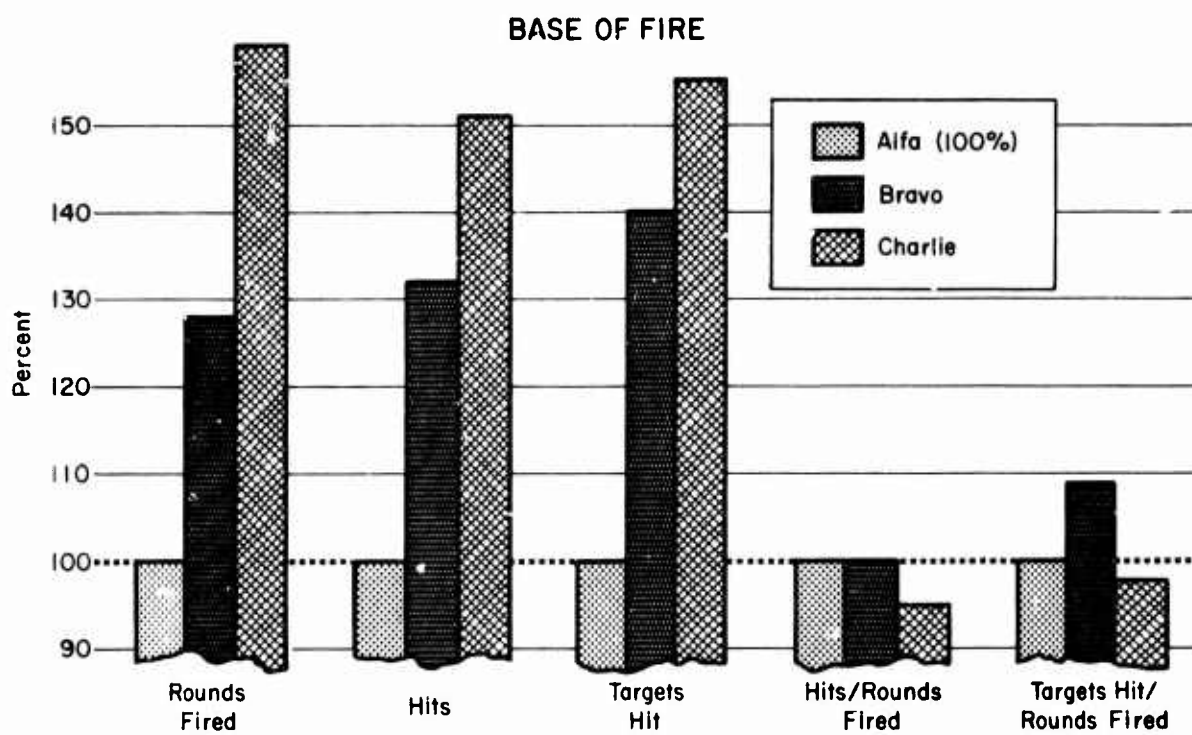Note: In Figures 13 and 14 above, Bravo = 1 MG, Charlie = 2 MG.

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FIGURE 15   COMPARISON OF THREE SQUAD ORGANIZATIONS

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4. EFFECTIVENESS AND NUMBER OF WEAPONS

a. Certain of the data presented in the foregoing paragraphs point
to a major anomaly. Given a weapon of a particular hit probability, one
would expect that an increase in the number of weapons would result in
a proportionate increase in the number of hits. However, this was not
the case in this experiment. On base of fire Course I the CHARLIE squad
with two M60 machine guns nearly doubles the number of hits (92% in-
crease) recorded by the BRAVO squad with one machine gun, but increases
on the other three courses were much smaller with CHARLIE squad gen-
erally about 55% greater than the BRAVO squad (Tables 4 and 5, pp. 24
and 29). As the number of rifles was increased from five to six to seven
per squad, the efficiency of the individual rifle, in terms of hits/rounds
fired, decreased from .0442 to .0419 to .0415 on Course I. The same
trend is evident on Course II where the hits/rounds fired decreased from
.0547 to .0517 to .0489 as the number of rifles was increased from five
to six to seven per squad.

b. The explanation of this anomaly is not found directly in the data
from the experiment. Some factors which may have contributed to the
number of hits not being exactly additive are: rounds falling outside of
the target area, scoring errors, and firer interaction.

5. DISTRIBUTION OF HITS OVER TARGET AREA

a. In the foregoing paragraphs the number of different targets hit
has been used as a measure of the distribution of fire. An extension of
this measure is given by a measure of the uniformity with which the tar-
gets hit are distributed over the target area. Each course was divided
into lanes 10 meters wide, each lane containing an identical number of
targets uniformly distributed over the lanes (terrain permitting). An
analysis was made of the lane distribution of the targets hit; that is, the
examination concerned distribution only across the width of the target
area, without respect to depth.

b. None of the squad organizations achieved uniform distribution
of fire over the target areas on either the base of fire or assault courses.
(See Annex C, Data Analysis, pp. 88 and 89.)

6. DISTRIBUTION OF HITS OVER TIME

a. Eighty of the 160 hit indicators on base of fire Courses I and
II were wired to Esterline-Angus pen recorders, recording the hits on
paper tape as they occurred in time. The data recorded in this manner
show some inaccuracies, particularly in the total hit count. The in-
accuracies were due to such factors as recording as hits the impact of
dirt or rock fragments kicked up by near misses, recording only one hit
when two rounds struck a hit indicator at the same instant, and break--

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downs in switch circuitry. For these reasons, the manual count of hits was considered to be more accurate; however, only the pen recorder was capable of relating hits to time.

b. Figures 16 and 17 following present the distribution of hits by M14 rifles and M60 machine guns over time on Course I. The firers in all cases were instructed to distribute their fires evenly over an eight minute period. The results for each weapons group are expressed as the percent of total hits by that group occurring within each 30-second interval. As indicated by a line on each graph, an even distribution would require that 6.25% of the total hits occur within each of the 16 time intervals.

c. None of the squads distributed their hits on base of fire Course I uniformly over time, and it does not appear that any one squad was better than any other in this respect. These results from base of fire Course I are supported by results from base of fire Course II.

7. COMPARISON OF MOUNTS, M60 MACHINE GUN

a. As shown in Table 6, page 36, at a range of 400 meters the M60 fired from the bipod mount appeared to yield a somewhat higher hit probability than when used with the tripod mount, although these differences are not statistically significant. The observed difference may be due in part to a difference in firing techniques observed during the tests. Gunners using the bipod seemed more inclined to concentrate their fire on suspected target locations; since traversing required shifting the body and moving the mount, there was less tendency to fire into open areas where apparently no targets existed. With the tripod, gunners seemed to devote relatively more attention to the mechanics of adjusting their weapons and less attention to the target area itself.

b. At the 850-meter range, any such difference in technique would have less effect on the results, since at this distance a gunner can no longer distinguish between suspected target locations and the relatively small open areas intervening. The table shows that the performance with the bipod mount at 850 meters was similar to that obtained with the tripod. Since these latter data are based on only two runs with the bipod mount, compared to six runs with the tripod, they can be considered only suggestive at best.
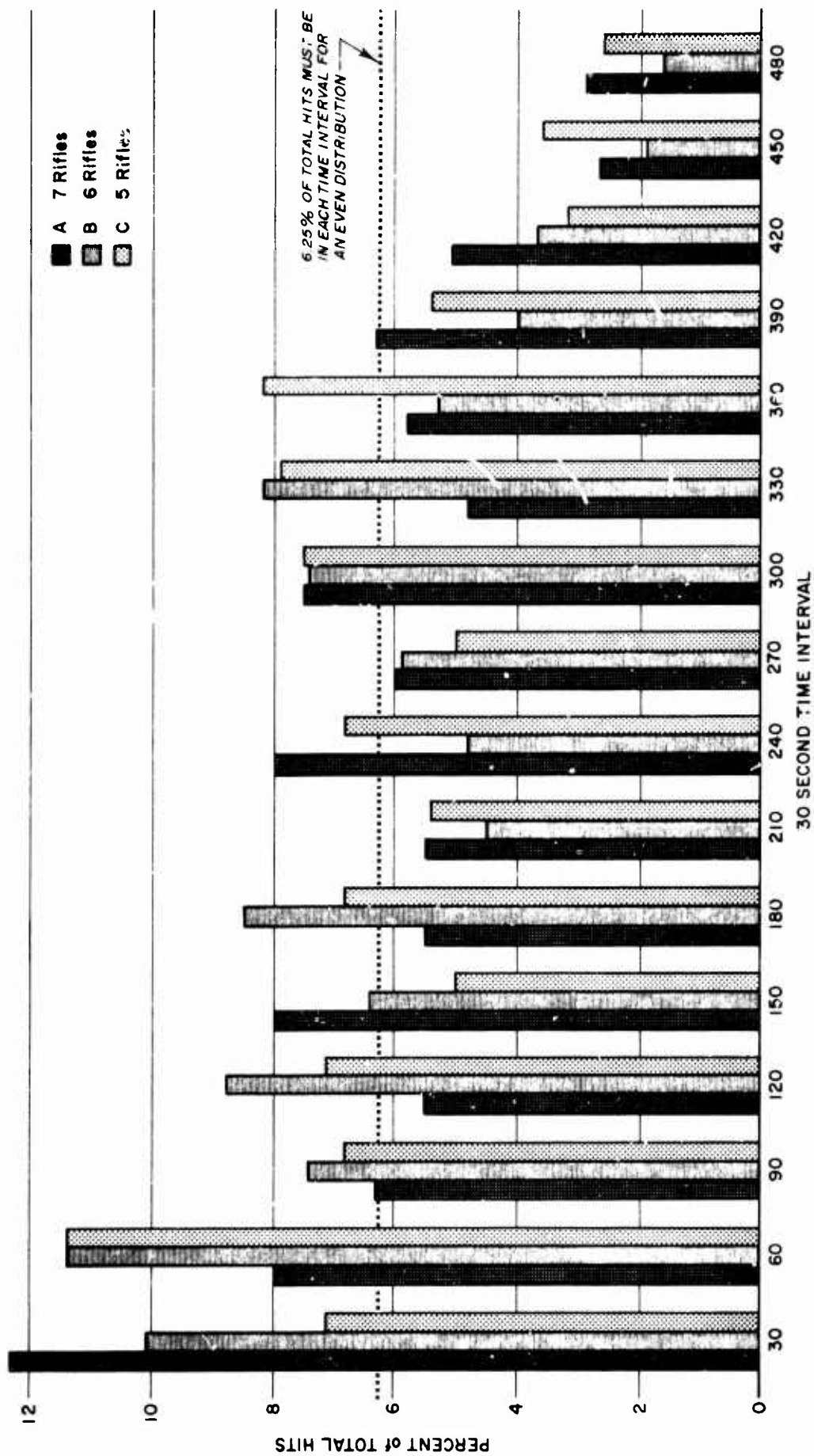
33

FIGURE 16

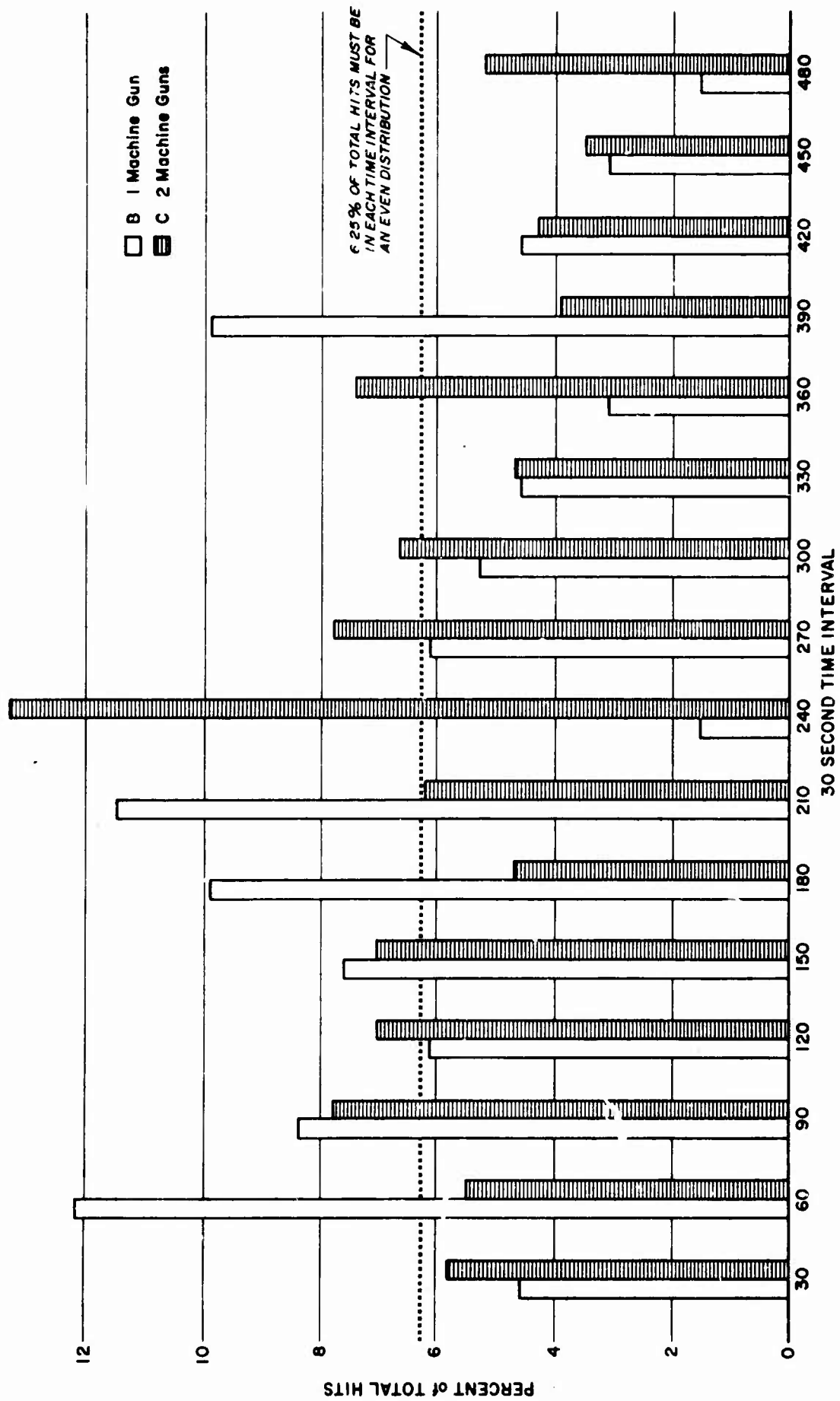PERCENTAGE OF TOTAL HITS PER TIME INTERVAL - RIFLES

Base of Fire, Course I

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FIGURE 17

PERCENTAGE OF TOTAL HITS PER TIME INTERVAL – MACHINE GUNS

Base of Fire, Course I

35

TABLE 6
M60 WITH BIPOD AND TRIPOD MOUNTS
AT 400 AND 850 METERS

Range	Weapons	Hits/Rd Fired	Tgts Hit/Rd Fired
400 Meters	2 M60 Bipod	.0338	.0248
	2 M60 Tripod	.0261	.0186
850 Meters	2 M60 Bipod	.0208	.0171
	2 M60 Tripod	.0232	.0175

8. M14 (MOD) RIFLE IN THE ASSAULT ROLE

a. During Week 5 of the experiment, six runs were made on assault fire Course III using the M14's fully automatic capability to determine the extent of hit probability under these conditions. In Table 7, the results of this portion of the experiment are compared with the results obtained earlier for the M14 and the M60 fired on the same course.

Although none of the differences shown in the table are statistically significant, the M14 used as a semi-automatic weapon appears to yield the highest probabilities both in terms of hits and targets hit per round fired. More importantly, there appears to be no difference between the M14 (Mod) and the M60 machine gun in the assault role; the hit probability of the M14 (Mod) is somewhat lower than that of the M60 when there is one machine gun in the squad and somewhat higher than the M60 when there are two machine guns in the squad. These results, however, do not take account of the fact that the M14 (Mod) was fired at shorter ranges than the M14 and M60. It seems likely that under comparable conditions of longer range the M14 (Mod) results would have been degraded. These results also ignore the possible effects of weapon interaction since they are based on a squad firing full automatic simultaneously with seven M14 (Mod) rifles rather than with one or two, which is the more likely case.

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TABLE 7

M14 (MOD) FULL-AUTOMATIC COMPARED WITH
SEMI-AUTOMATIC AND MACHINE GUN FIRE

(Assault Fire)

Weapon(s)	Hits/Rd Fired	Tgts Hit/Rd Fired
7 M14's (Semi-Auto.)	.1272	.0795
7 M14's (Mod) (Full-Auto.)	.0946	.0740
1 M60	.1055	.0786
2 M60	.0828	.0602

9. M79 IN BASE OF FIRE ROLE

a. The M79 grenade launcher was fired from 300 and 200 meters at a hillside target area 200 meters wide and 40-50 meters deep. The grenadiers were given eight rounds each and instructed to deliver uniform fire over the area. They were permitted to fire for eight minutes on the 300 meter range, five minutes on the 200. Measures were taken of point of impact and time of fire. As was done on the other courses, each grenadier was informed as to the approximate distance to the objective. Four grenadiers were used, the two best and two poorest marksmen as determined by earlier experimentation involving firing with and without a lateral observer.

b. As shown in Figures 18 and 19, the firer was able to cover the area adequately. The lethal radius of the grenade fragments is approximately five meters; consequently, this distance is indicated to scale around the points of impact. The time after the start of the run when the round was fired is shown.

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FIGURE 18 BURST LOCATIONS AND TIMES OF FIRING
Base of Fire - M79 300 Meter Range

FIRER 1

Time measured from start of run

Round 8, above, was a dud and bounced beyond range.
The estimated impact point is shown.

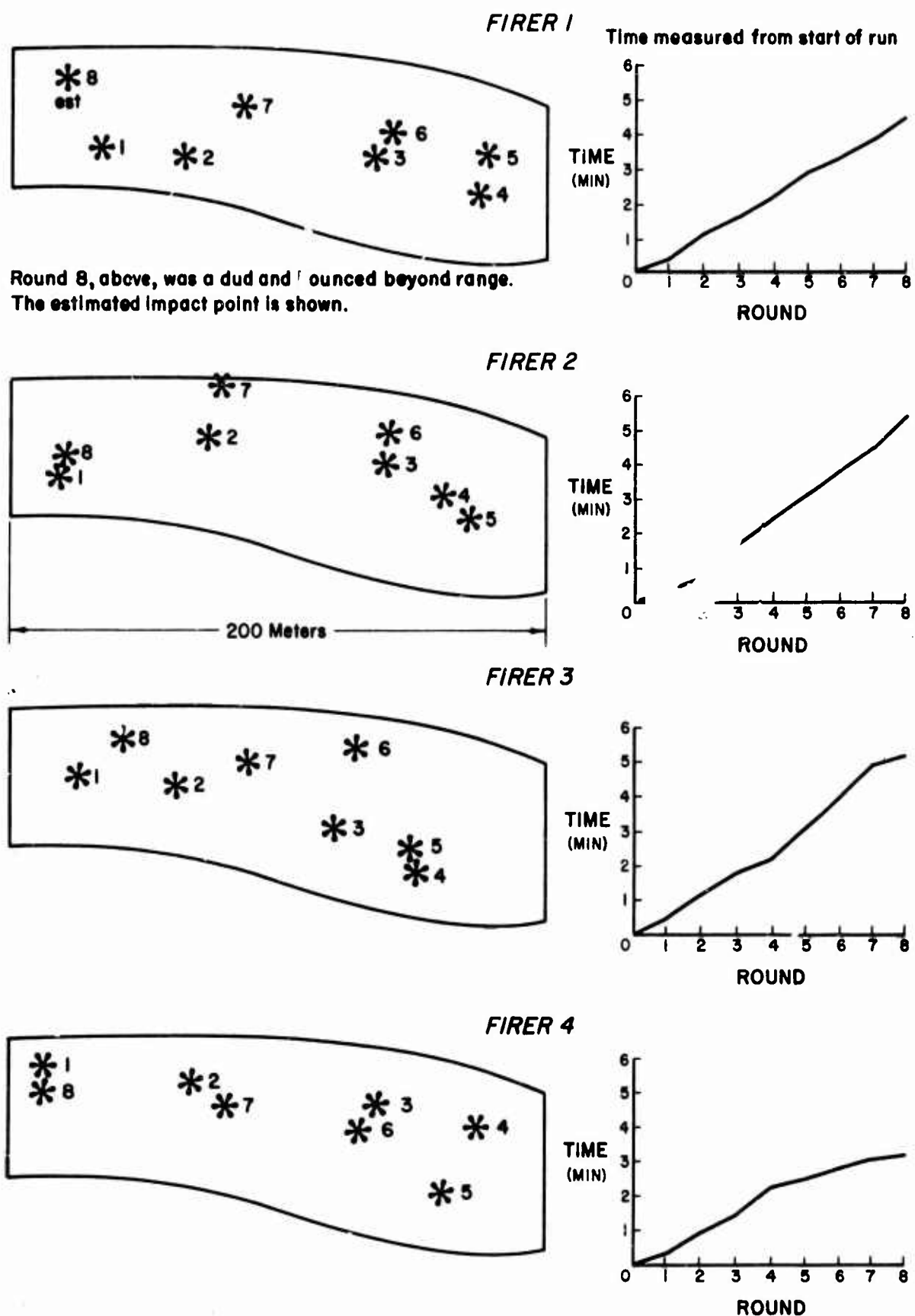FIRER 2

200 Meters

FIRER 3

FIRER 4

FIGURE 19   BURST LOCATIONS AND TIMES OF FIRING
Base of Fire – M79   200 Meter Range

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10. M79 ASSAULT FIRE

a. Experimentation with the M79 grenade launcher in an assault fire role was conducted on Course III. A single grenadier fired five M79 HE rounds into the left half of the target area while moving from the assault line at 125 meters from the target area to the cease fire line at a range of 60 meters. The procedure was repeated four times with a different grenadier firing each time, i.e., a total of four runs made up this test. The grenadiers were instructed to distribute their fire to cover the left half of the target area.

b. In order to obtain an indication of combined effects of the rifle, machine gun and grenade launcher, data were selected from the M79 assault test described above and from the M14 and M60 runs on the same course, described previously. Table 8 below represents the number of targets hit (distribution) during six runs, two each by the M14 rifle, M60 machine gun, and M79 grenade launcher. The cover in the target areas of Course III comprised low trees and brush, which probably contributed to the large number of targets hit by the M79 as compared with the machine gun.

TABLE 8

NUMBER OF TARGETS HIT, BY WEAPON TYPE

(Composite of six individual runs on Assault Course III)

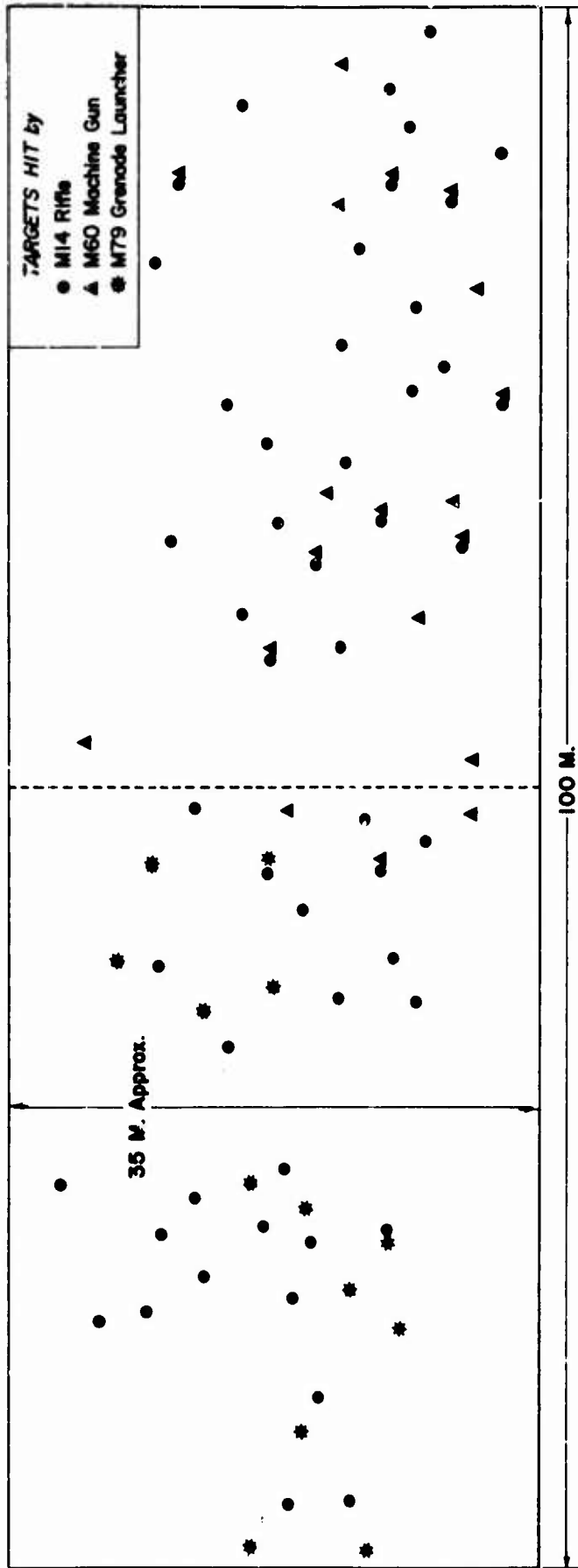| Squad Type	Wpn	Nr Wpns	Wr Rds Fired	Nr Targets Hit		
				Left*	Right*	Total
BRAVO	M14	7	622	25	25	50
	M60	1	200	3	15	18
	M79	1**	5	13	—	13
CHARLIE	M14	7	537	20	23	43
	M60		400	6	11	17
	M79	1**	5	13	—	13

* Left and right half of the target area on Course III.

** Although BRAVO organization contained two M79s, for experimental purposes, only one M79 was fired on this course.

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c. In Figures 20 and 21, following, the number of targets hit by the three weapon types during their separate sub-runs are combined and plotted according to their location on Course III, to depict a representative distribution of fire. By direction, the grenadier fired only into the left half of the course for both squad organizations. In the BRAVO runs (Figure 20), the M60 machine gun was positioned on the right side of the course.

d. The M79 grenade launcher was also tested in the assault role on Course VII; here the determination of point of burst was made. A grenadier fired five rounds at the target area while advancing from a distance of 125 meters to 50 meters from the target area. Four grenadiers were used, the two best and two poorest marksmen as determined earlier.

The results of the firing on this course show that a grenadier is capable of delivering fire on an objective while advancing. The accompanying Figure 22 shows the point of burst, lethal radius and time of firing each round for the four firers.

FIGURE 20

LOCATION OF TARGETS HIT, BY TYPE OF WEAPON FIRING

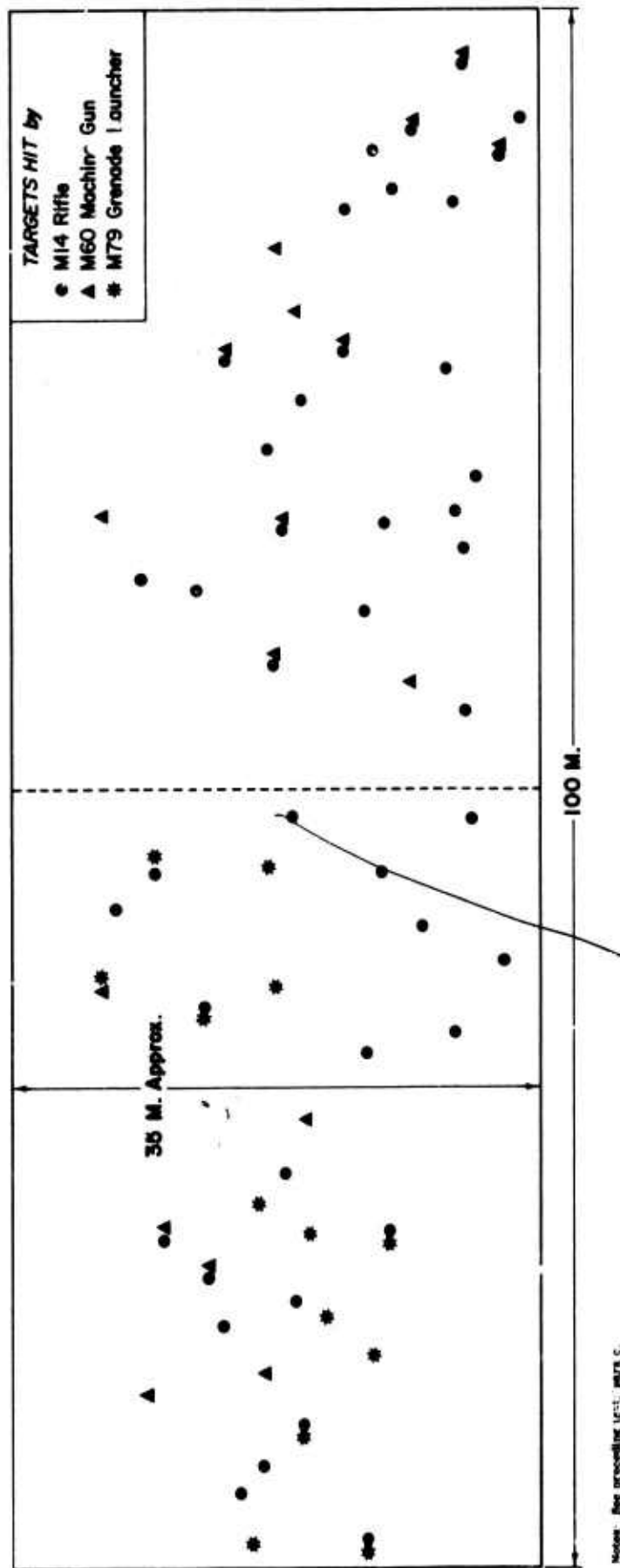BRAVO (-) Squad, Assault Course III

Notes: See preceding text, para c.

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FIGURE 21

LOCATION OF TARGETS HIT, BY TYPE OF WEAPON FIRING

CHARLIE Squad, Assault Course III

43

FIRER 1

Time measured from start of run

FIRER 2

100 Meters

FIRER 3

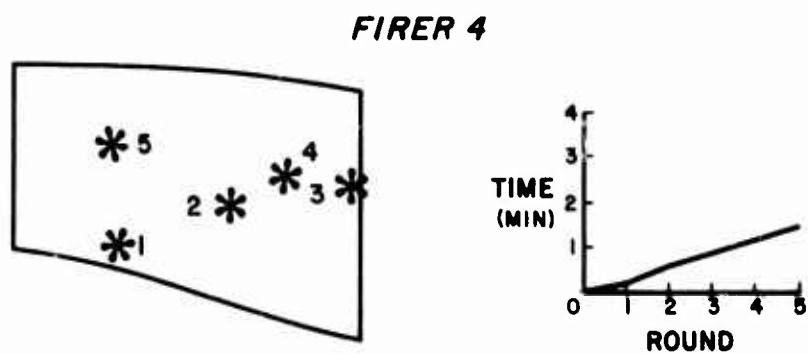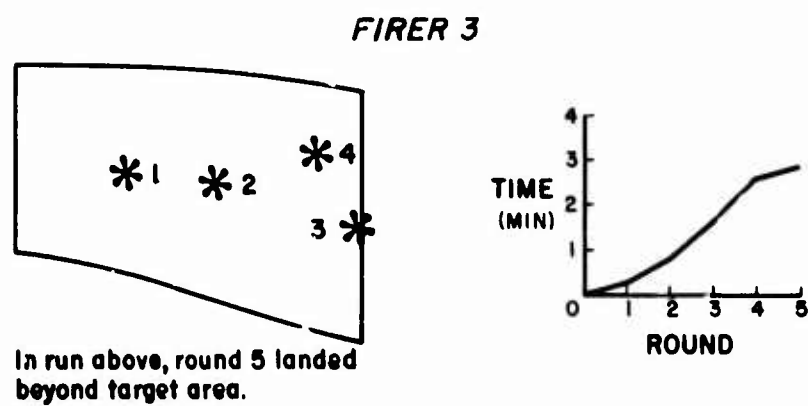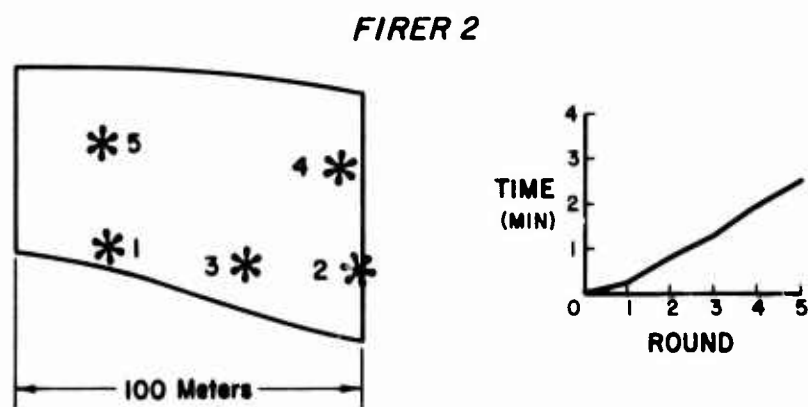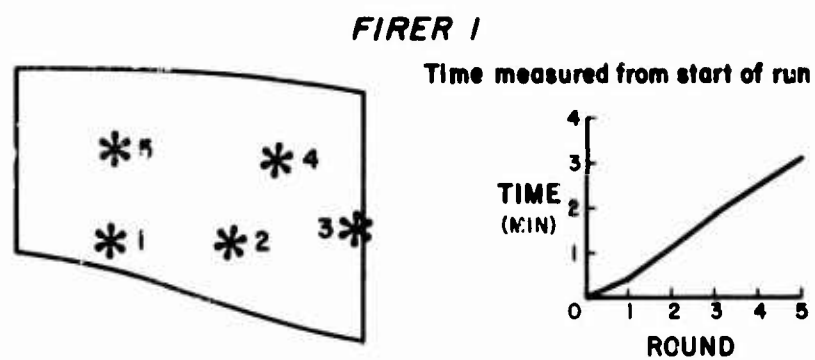In run above, round 5 landed
beyond target area.

FIRER 4

FIGURE 22   BURST LOCATIONS AND TIMES OF FIRING
M79 in Assault Course VII

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11. M79 IN WOODED AREAS

a.   The M79 grenade launcher was fired at two target areas near and under trees. These target areas were selected to observe the problems associated with firing in wooded areas. No firing from within wooded areas was conducted for safety reasons.

The designated target areas were sheltered under tall trees and the trajectory of the grenade required it to go through or over other trees. Three grenadiers fired four rounds each at each target area and at two different ranges (200 & 300 meters) for a total of 48 rounds.

b.   Of the 48 rounds fired, 31 were tree bursts, 17 were ground bursts. The ability of the grenadier to place rounds in areas behind trees is severly hampered by the probability of rounds bursting short of the target.

TABLE 9

RESULTS OF M79 FIRING IN WOODED AREAS

	Area A		Area B	
	200m	300m	200m	300m
Tree bursts in target area	6	7	10	8
Ground bursts in target area	6	5	2	4

The effect of tree bursts is highly variable. A total of 4547 cardboard targets were laid flat under the trees and were examined for hits. As would be expected with the uniform fragmentation pattern of the grenade, high tree bursts would not penetrate targets; debris from the grenade and the tree would be found on the surface of the targets. Low tree bursts hit many targets, while a ground burst tended to get no hits other than the target on which it landed. Three samples are illustrated in accompanying Figures 23, 24, and 25.
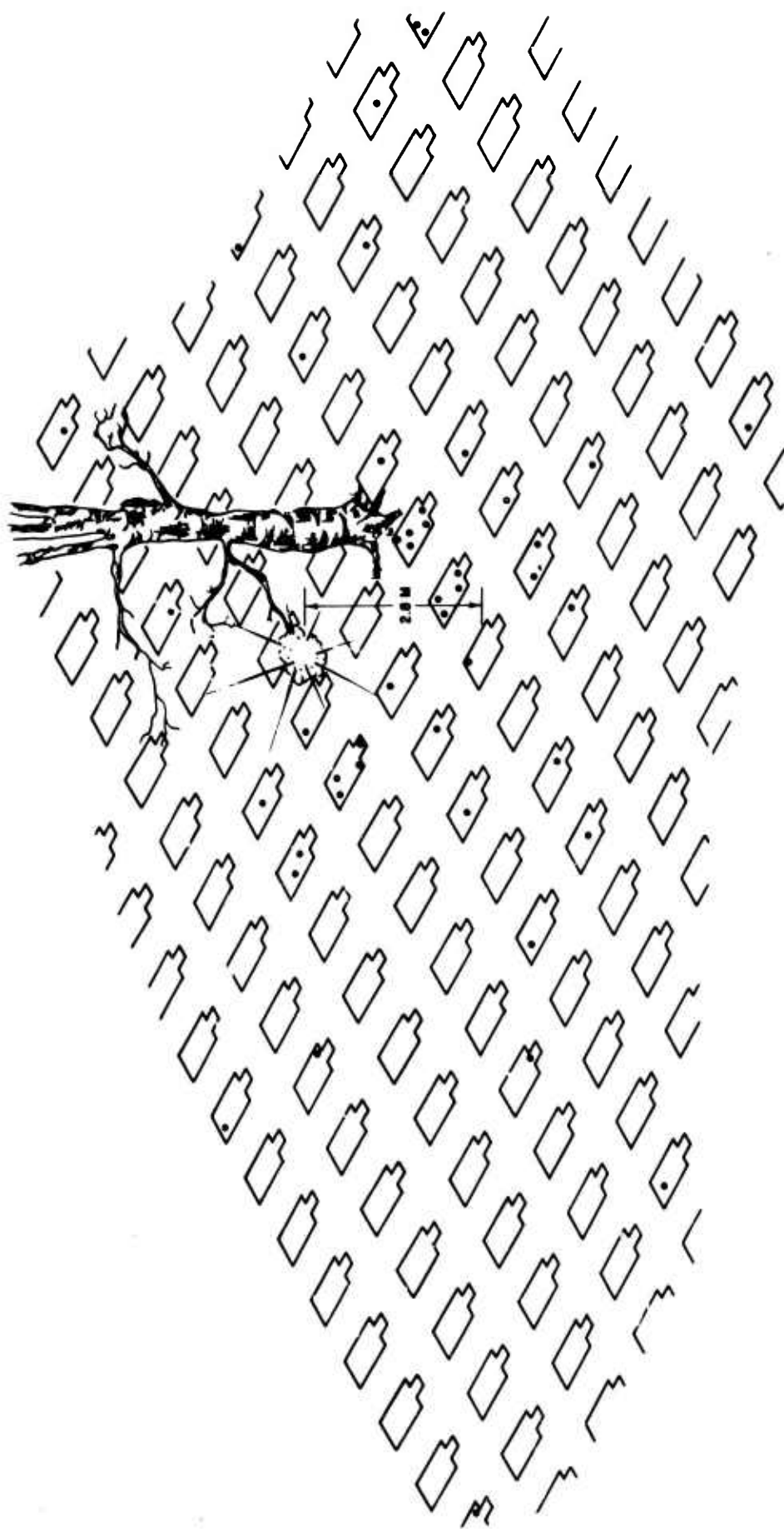
FIGURE 23

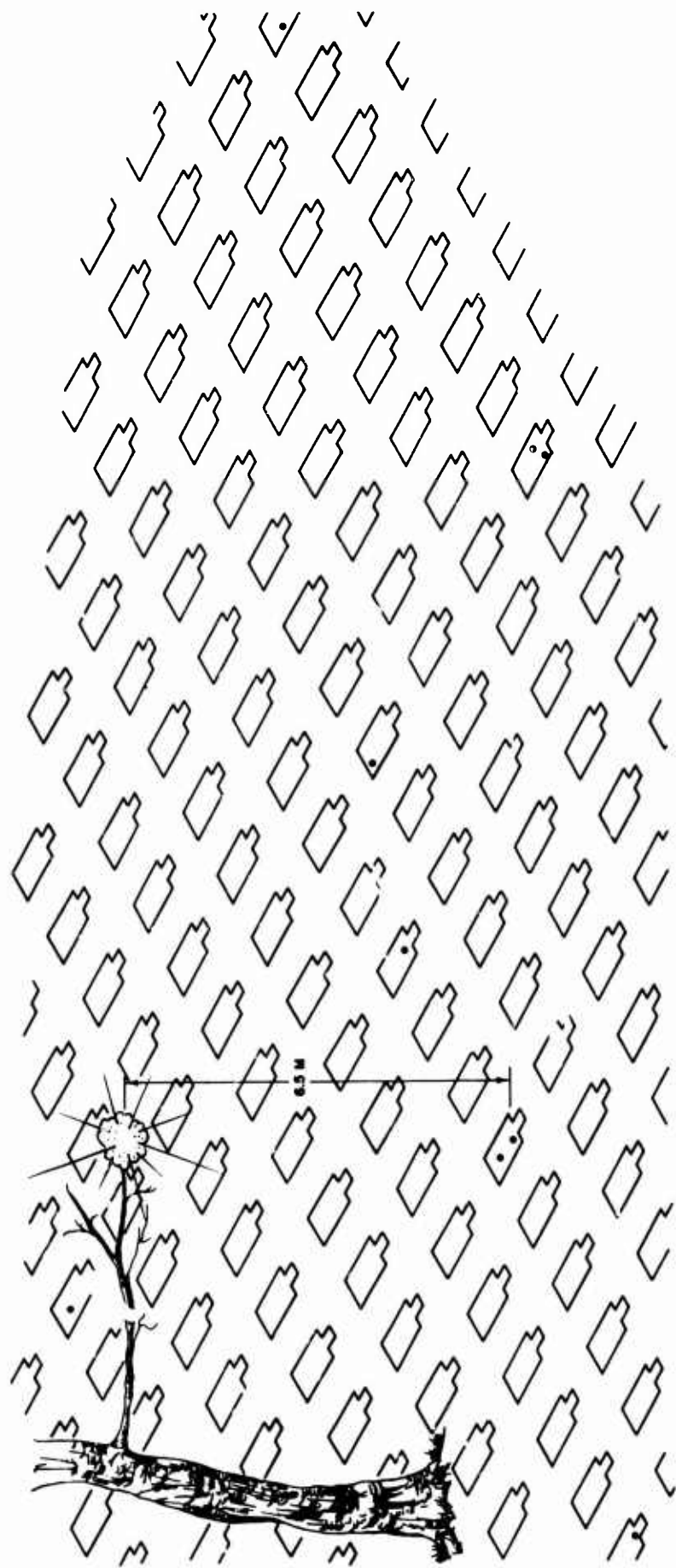EXAMPLE OF HIT PATTERN, LOW TREE BURST

FIGURE 24

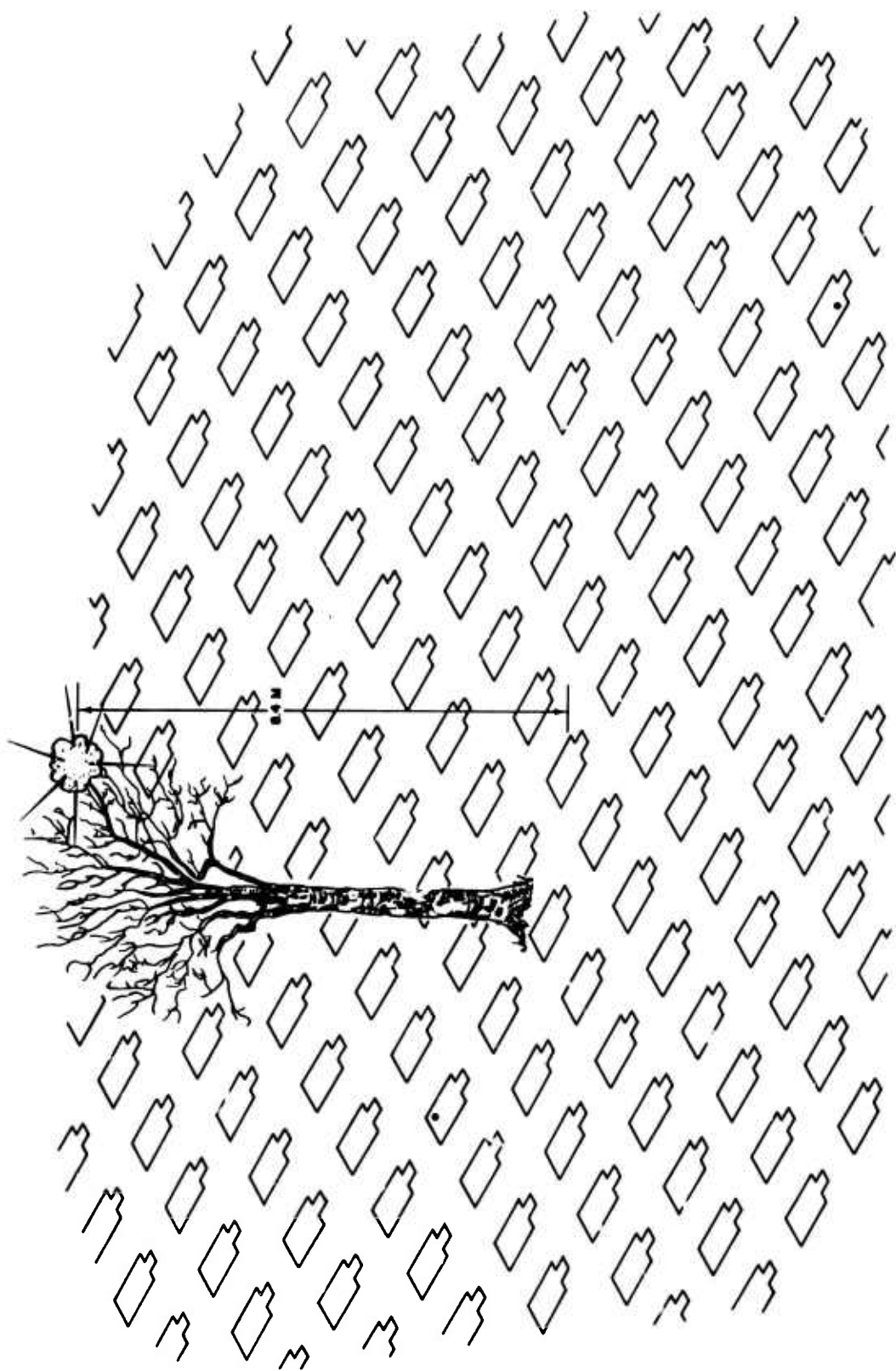EXAMPLE OF HIT PATTERN, MEDIUM HEIGHT TREE BURST

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FIGURE 25

EXAMPLE OF HIT PATTERN, HIGH TREE BURST

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12. M79 WITH AND WITHOUT A LATERAL OBSERVER

a.   The lateral observer did not significantly improve the accuracy of the grenadier, even though he was more accurate in sensing than the firer.   Although the correlation between sensing and actual error was .89 for the observer and .62 for the firer, the average miss distance (the resultant of the range and deflection error components) was 8.9 meters with the observer aiding in adjusting (all rounds subsequent to the first), and 9.8 meters without the observer.   During this experiment sensing was aided by soil conditions: the explosion raised a dust cloud which silhouetted the target if over, and obscured the target if short.

b.   As the grenadier adjusted on a target, he improved in accuracy up to the third round.   These data are presented in Figure 26.   That only two rounds were needed for adjustment is probably due to the familiarity of the firers with the firing course.   Had they been less familiar with the course, they might have required more rounds for adjustment.

c.   On the third, fourth, and fifth rounds the firers achieved an average miss distance from each target of approximately 4% of the range to the target.   This is shown in Figure 27.   Errors in range are much larger than errors in deflection as would be expected.   This can be seen in Table 10 which presents the average of the range errors and deflection errors by target.

TABLE 10

AVERAGE ERRORS IN METERS BY TARGET, ALL FIRERS

Range to Target	Range Errors	Deflection Errors
121	4.5	.4
197	6.0	.8
254	7.9	1.1
357	13.8	2.4

The accuracy of the firers varied considerably, the best having for all rounds a mean miss distance of 15.0 meters, the worst 36.7.
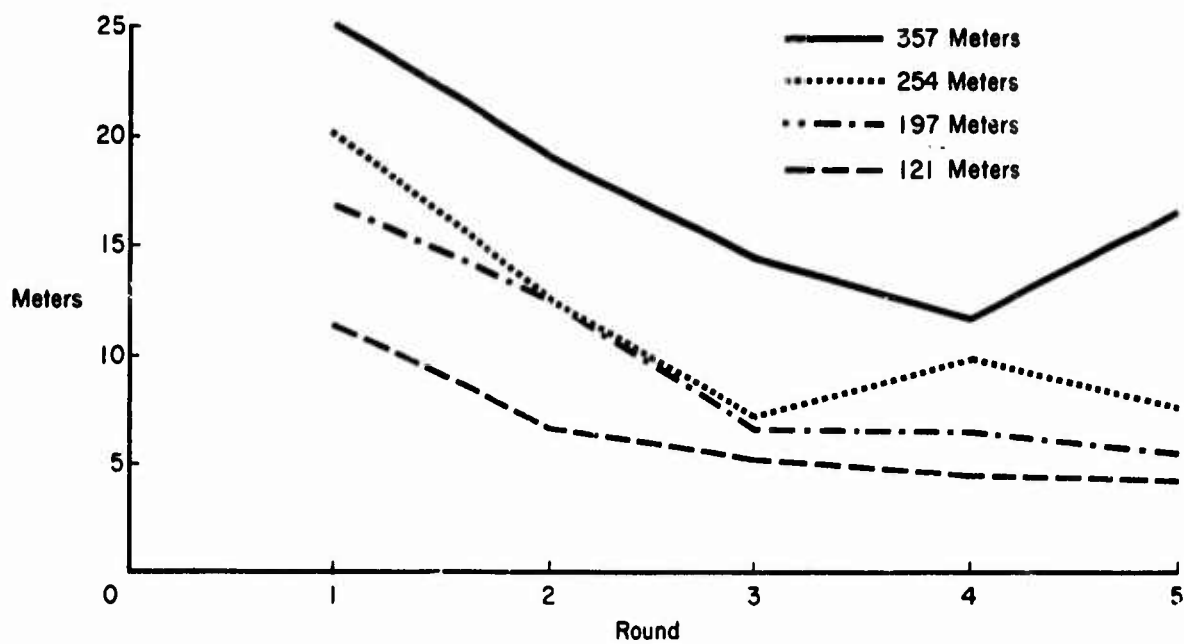
49

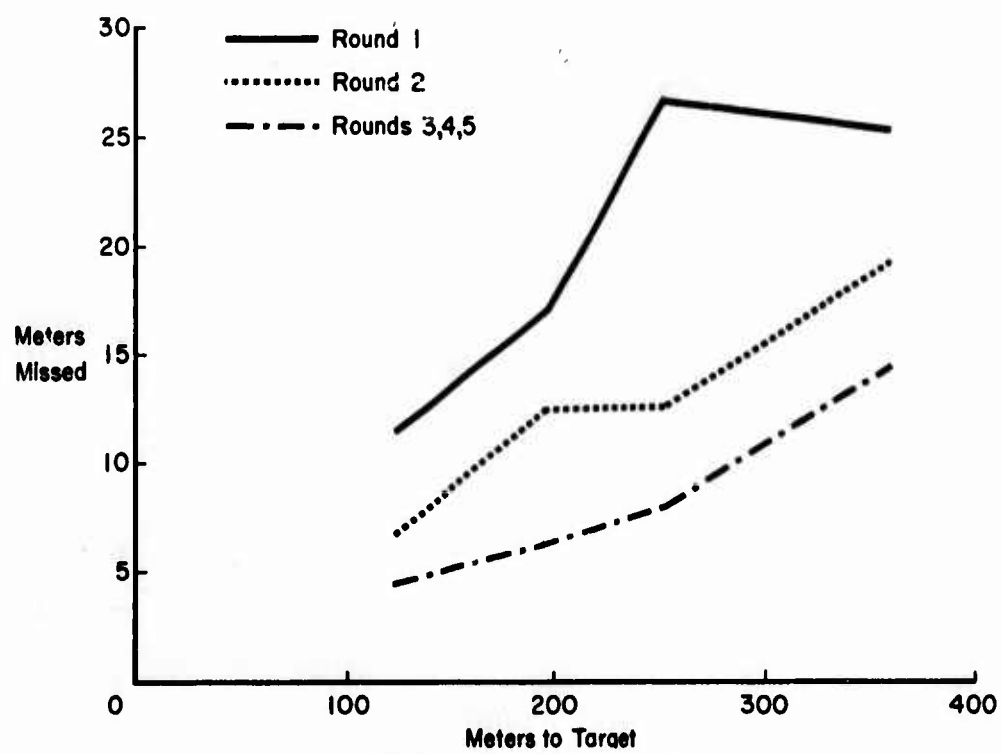FIGURE 26

AVERAGE MISS DISTANCE FOR EACH SUCCEEDING ROUND

FIGURE 27

AVERAGE MISS DISTANCE AS A FUNCTION OF RANGE TO TARGET

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13. RATE AND ACCURACY OF FIRE, M79

The M79 was fired as rapidly and as accurately as possible according to the following procedure. Three window-frame targets, each approximately 2' x 3' in size, were used. Five rounds were fired from a sandbagged position at one of the targets 120 meters away. The grenadier then moved out toward the target area, firing five rounds at a second target as he progressed to a distance of approximately 110 meters from that target, and firing a final five rounds at the third target as he moved from 110 meters to 100 meters approximate distance from that target. Measures were taken of the point of impact of the rounds and of the time required to fire the rounds.

a. Rate of Fire

(1) In firing from the sandbagged position, the grenadier had the rounds laid aside on the sandbags in order to facilitate loading. The average time for five rounds was one minute, four seconds, or about 13 seconds per round. The fastest man took 10 seconds, the slowest, 15 seconds per round. Six of these firers had fired over 50 rounds prior to this test; the other two had fired only four rounds. Both of these groups had special training in rapid-firing the grenade launcher, but the two with little previous firing experiences were the slowest. The other six firers averaged 12 seconds per round.

(2) On the assault phase of the rapid fire, the grenadiers had to remove the round from their bandoleer; this slowed them slightly. The average time for the 10 rounds was 13.6 seconds per round for all firers. For the six experienced firers, the time was 13.1 seconds.

(3) The grenadier thus can fire approximately 2-1/2 pounds of ammunition a minute and would need slightly over five minutes to fire a basic load of 27 rounds.

(4) Movie records showing rapid fire of the grenade launcher during the assault were analyzed to determine which actions take the most time and, thus, might prove to be most fruitful for improvement. Of the total time per round, 25% was taken in removing the new round from the bandoleer and 35% in aiming and firing. A detailed breakdown is shown in Figure 28.

(5) In connection with the removal time mentioned in paragraph 4, above, it should be mentioned that during this phase of the M79 grenade launcher test, the bandoleer was modified to facilitate the removal of individual rounds. The center round in the three-round plastic egg-crate holder often had a tendency to stick; in fact, many times the grenadier had to use both hands to remove the center round. Since this problem

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100* — Round fired

90

80 — Aiming

70

— Closing Weapon (ready to fire)

60

— Loading round

Percent 50

40

— Removing round from bandoleer

30

20 — Extracting spent shell from weapon

10

— Breaking open the weapon

0 — Round fired

* Average time was 13.6 seconds per round.

FIGURE 28

PROPORTION OF TIME SPENT ON EACH STEP
ON M79 FIRING DURING THE ASSAULT

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occurred with many but not all of the plastic holders, the difficulty was possibly due to variations in the material used. Modification consisted of removing the plastic holder and sewing the pockets of the bandoleer to make four separate pockets.

    b. <u>Accuracy</u>

    (1) The grenadier was instructed to fire at the frames as accurately and rapidly as possible. The points of burst on the slope behind and in front of the frames were located with respect to the frame centers. Battle sights were used and the movement of the firer toward the targets required adjustment in hold-off. The three frames were on the hillside, their centers elevated 3.6, 3.6, and 5.2 meters above the average height of the launcher position, and their corresponding distances were 120, 110, and 100 meters from the firer.

    (2) The average miss distance in the plane of the target (resultant of the horizontal and vertical error components) for the stationary firer behind the sandbags was .98 meters; the average horizontal error was .46 meters, the average vertical error was .74 meters. The advancing firer had an average miss distance in the plane of the target of 1.0 meters; the average horizontal error was .79 meters; the average vertical error was .52 meters for the advancing firer.

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V
Military Evaluation

1. GENERAL

In order to recommend the optimum rifle squad and platoon organization the evaluation presented here examines the findings of this experiment in context with the results of the Optimum Composition of the Rifle Squad and Platoon Experiment (Reference 20, p. 94).

2. NUMBER AND TYPES OF WEAPONS IN THE RIFLE SQUAD

a. Machine Guns

(1) In comparison with the squads without machine guns, the squads with one machine gun provided a greater volume of fire, more hits, and better distribution in terms of number of targets hit, while obtaining about the same ratios of hits and targets hit to total rounds fired. (Figure 15, p. 31) It was found that squads with two machine guns fired more rounds, scored more hits on targets, and hit more targets than squads with one machine gun or with rifles only. This condition was true in both the base of fire and assault roles. The gains, however, were not proportionate to the increased expenditure of ammunition (See Tables 4 and 5, pp. 24 and 29.)

(2) Whether the machine gun should be organic to the rifle squad or attached from a weapons squad is not primarily a question of firepower. When machine guns are a part of a weapons squad, they are habitually or frequently attached to the rifle squads. On the other hand, when the machine gun is organic to the rifle squad, it may occasionally be detached and massed with other machine guns of the platoon. At any rate, whether organic or attached, the machine gun is more often found with the rifle squad than with the weapons squad. If organic, the machine gun is more responsive to the needs of the squad, the machine gunner and his assistant are trained together with other squad members, the machine gun is protected by the riflemen of the squad, and the squad leader's span of control is not increased to encompass an attached element. (Reference 20, p. 94)

(3) Difficulties encountered in reloading the M60 machine gun and clearing stoppages have raised a question as to the suitability of this weapon for assault use. These problems were evident during the first few runs of the experiment, but were largely overcome with practice. Several suggestions for further reducing the difficulty of loading the M60 were made by participating personnel. These included enlarging the magazine to accommodate two belts of ammunition linked together, which would provide sufficient rounds (200) for the average assault. The first link should have a tab similar to that provided with .30 caliber linked

ammunition to assist in loading the belt in the gun. Another suggestion was that strengthening the wire frame of the ammunition magazine would prevent crushing the pouch and thus help the belt to feed more smoothly from the magazine into the weapon.

(4) Results of experimentation with the machine gun on bipod and tripod mounts revealed that in providing area type fire the bipod mount is equal to and perhaps superior at shorter ranges and about equal to the tripod at greater ranges. (Paragraph 7, p. 33) The tripod therefore need be carried by the machine gun crew only when it is to be employed in a prepared defensive or other static situation.

b. Grenade Launcher

(1) The findings with respect to the M79 grenade launcher indicate the potential usefulness of this weapon within the rifle squad. In the base of fire role, the grenade launcher proved capable of distributing fire over a 200 meter wide target area (Figures 18 and 19, pp. 38 and 39). The tests for accuracy and rate of fire indicated that a grenadier firing at point targets can exhaust his basic load of 27 rounds in slightly over five minutes with effective accuracy either while stationary or while moving in the assault (Paragraph 13, p. 51).

(2) In the assault, a grenadier is capable of distributing fire on an objective while advancing and the data of Table 8 (p. 40), show that the grenadier hit an average of 13 targets for five rounds fired during the assault. Furthermore, the grenade launcher is effective against troops behind certain types of cover where the rifle and machine gun cannot reach — although its uncertain effects in heavily wooded areas severely limit its usefulness in jungle or forests (Paragraph 11, p. 45).

(3) No direct comparison can be made between the M79 grenade launcher and small arms (rifles and machine guns) because the effects of the 40mm high explosive fragmentation round and the 7.62mm round are entirely different.

(4) In terms of their number within the squad, two grenade launchers appear to offer maximum advantage without unduly reducing the number of rifles. The latter, because of their versatility, remain the basic weapon of the squad. Considerations which recommend the use of two grenade launchers with the squad are as follows:

(a) In both the base of fire and assault roles, a squad with two grenade launchers generally can provide more effective fire than can a squad with one grenade launcher and an additional rifle in lieu of the second grenade launcher. Firing alternately, the two grenade launchers can maintain a reasonably constant rate of fire and can also provide

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sufficient duration of fire to cover the assault.

(b) In the defense, two grenade launchers can cover both flanks of the squad, can cover two avenues of approach, and can reduce dead space along FPL's.

(c) Having two grenade launchers in the squad permits each fire team to have an area fire capability.

(d) Two grenadiers in the squad permits more grenade launcher ammunition to be carried.

c. Rifles

(1) The all-around versatility of the rifle and its requirement in patrols, outposts, target designation, sniping, and close range use during in-fighting on the objective, dictate its role as the primary weapon of the rifle squad. Furthermore, the data on the experiment indicate that within the limits examined in this experiment, the rifle sustains its relative effectiveness as more of these weapons are used in the squad. Table 4 (p. 24), which presents the firing data for the base of fire course and affords a comparison between squads with five, six, and seven rifles, shows that as the number of rifles increase there is an increase in total hits and targets hit with only a relatively small decline in hit probability and hit distribution on a per-round basis.

(2) Because the M14 (Modified) rifle did not demonstrate significantly better hit probabilities than the M60 machine gun (paragraph 8, p. 36), and because of its inherent disadvantages as compared with the machine gun (stability, durability), there appears to be little reason for including this weapon in a squad that has an organic machine gun.

d. Recommended Squad

(1) The above discussion points to a rifle squad organization with one machine gun, two grenade launchers, and the remaining weapons rifles. In this experiment, the BRAVO squad armed with these weapons provided a better balance of all firepower factors: volume (number of rounds fired), effectiveness (number of hits), distribution (number of targets hit), hit probability (number of hits per rounds fired), and hit distribution (number of targets hit per rounds fired) in both the assault and base of fire roles.

(2) The machine gunner and the grenadier both require a pistol for personal protection. This requirement can be deleted for the grenadier when a suitable cannister round for the grenade launcher is available to provide close-in personal protection.

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(3) The assistant machine gunner can function as one of the grenadiers. The employment of the M79 seldom requires that it be fired at the maximum rate, and an assistant machine gunner will normally have sufficient time to perform as a grenadier.

(4) The rifle squad with one machine gun may appear to have a disadvantage in that the fire teams are unbalanced in types of weapons. At squad level, however, the fire teams are not employed as a base of fire and a maneuver element as such, but rather each team supports the short movement of the other alternately until they arrive at a point short of the objective where the squad reforms and assaults the objective as a unit. Seldom will fire teams be operating so far apart that they will be out of range of any of the squad weapons.

(5) The only variation between the recommended squad and the BRAVO squad of the experiment is that in the former the assistant machine gunner is armed with a grenade launcher rather than a rifle. This change permits all squad members armed with the rifle to be utilized fully in the role of riflemen in both the base of fire and assault while also providing two grenadiers.

3. THE RIFLE PLATOON

a. Platoon Structure

The rifle platoon with four identical rifle squads has advantages over the platoon with three rifle squads and a weapons squad. The advantages given below are taken from the report of the Spring 1961 Experiment and are presented here for the convenience of the reader.

(1) When organic, the machine guns are more responsive to the needs of the rifle squad leaders and reaction time required to bring effective machine gun fire on enemy positions is thereby reduced.

(2) The platoon leader's control problems are reduced when the platoon does not contain dissimilar elements.

(3) Flexibility of employment is increased by having a greater number of rifle squads to employ in the base of fire or in the maneuver element. Machine guns are always present in both the base of fire and assault. A wider variety of platoon formations can be assumed, to provide greater flexibility and security than is possible with the rifle squad - weapons squad combination.

(4) In the defense, four rifle squads can provide more effective coverage and with all weapons integrated at squad level the position can be occupied with greater speed and ease. In a perimeter defense the platoon with four rifle squads is best able to adapt itself to the terrain

and provide security in all directions.

(5) Greater simplicity of training and employment is achieved.

(6) The average rifle platoon leader (particularly upon mobilization) when leading a platoon with three rifle squads and a weapons squad will in almost all instances attach his weapons squad machine guns to the rifle squads to simplify their tactical employment. This attachment of machine guns results in his hav...ig only three elements to employ and increases appreciably the span of control required of the squad leaders who many times will also be inexperienced. On the other hand, when given a platoon with four identical rifle squads, each having all weapons integrated, the platoon leader has the increased flexibility of employing four elements, without increasing the span of control of his squad leaders.

(7) The advantage of integrating all weapons in the rifle squads becomes strikingly obvious when we consider the mechanized rifle platoon. Since the personnel capacity of the M113 armored personnel carrier will not permit the loading of a rifle squad and an attached support team from the weapons squad in one vehicle, the weapons squad will be forced to ride in its own carrier. This presents two major disadvantages. First, if the weapons squad carrier is hit the entire automatic fire capability of the platoon may be lost. Secondly, any attachments from the weapons squad made to the rifle squads cannot become effective until the dismount point is reached. The possible confusion of n arrying up the rifle squads and attached machine guns at the critical time of dismounting can be disadvantageous. The integrated squad does not have these drawbacks. The loss of a single carrier will still leave a better balanced fighting force and at the time of dismounting all weapons are immediately available and responsive to the squad leader.

b. Platoon Headquarters

As determined in the Optimum Composition of the Rifle Squad and Platoon Experiment (Reference 20, p. 94), the platoon headquarters should consist of a platoon leader, platoon sergeant, and radio operator/ messenger. These personnel should be armed with current weapons as follows: platoon leader, pistol; platoon sergeant, grenade launcher and pistol; radio operator/messenger, rifle. This combination of weapons with diverse capabilities in the headquarters frees the platoon leader from unnecessary weight, provides a rifle for launching pyrotechnics, and gives the platoon sergeant a grenade launcher that he can employ in the platoon's base of fire.

c. Additional Personnel of the Mechanized Rifle Platoon

In the mechanized rifle platoon the assistant platoon sergeant should be armed with a grenade launcher and pistol and the armored

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personnel carrier drivers should be armed with rifles. These individual weapons, in conjunction with the vehicular mounted weapons postulated for the optimum organization (Reference 20, p. 94), will provide the best combination for security of the five vehicles when the platoon is engaged dismounted.

VI
Conclusions and Recommendations

1. The conclusions and recommendations which follow are based on the Spring and Fall '61 experiments. The data and evaluations collected in these two experiments do not conclusively fix the optimum composition and organization of the infantry squad and platoon. The data collected in this experiment, for example, are confined to fire effects under a limited set of conditions. The results of both experiments have been examined and judged by military evaluators in the context of a broader set of relevant military considerations. The evidence nevertheless is considered sufficient to warrant the conclusions drawn.

2. CONCLUSIONS

    a. The Rifle Squad

        (1) The machine gun makes a necessary and substantial contribution to the firepower of the rifle squad, and one machine gun is relatively more effective than two in terms of ammunition expenditure. Better control within the squad is obtained when the machine gun is organic rather than attached.

        (2) The grenade launcher adds an effective area-fire capability to the rifle squad, and wide coverage can be achieved by providing one launcher for each of the two fire teams in the squad. The assistant machine gunner can function as one of the grenadiers and still perform the duties of assistant gunner.

        (3) The all-around versatility and effectiveness of the semi-automatic rifle creates the requirement for as many rifles as is consistent with controllability and the need for other weapons in the squad. It should be the individual weapon for squad members not otherwise armed with either the machine gun or grenade launcher.

        (4) Machine gunners and grenadiers require a pistol for personal protection.

    b. The Rifle Platoon

        (1) The four-rifle-squad platoon has advantages over the platoon with three rifle squads and a weapons squad in the increased responsiveness of the machine guns to the needs of the squad leaders, the reduced reaction time required to bring effective machine gun fire on enemy positions, improved control, simplicity in training and employment, greater flexibility of employment, more effective coverage and more rapid occupation of defensive positions, and dispersion of all weapons

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within the platoon.

(2) Platoon headquarters should be provided with a combination of weapons with diverse capabilities by arming the headquarters personnel as follows: platoon leader with pistol, platoon sergeant with a grenade launcher and pistol, and radio operator/messenger with a rifle.

c. The Mechanized Rifle Platoon

The mechanized rifle platoon should have an organization identical to that of the rifle platoon except that five drivers armed with M14 rifles, one assistant platoon sergeant armed with the M79 grenade launcher and pistol, and five armored personnel carriers should be added. (A discussion on the number of armored personnel carriers is found in Reference 20, p. 94.)

d. Miscellaneous

The suggested equipment modifications listed below should be investigated to determine the feasibility of their adoption:

(1) Modify the grenade launcher ammunition bandoleers to facilitate removal of the individual rounds (Paragraph 13a (5), p. 51).

(2) Modify the M60 machine gun magazine by enlarging it to accomodate two belts (200 rounds) of ammunition and strengthening the wire frame to prevent distortion and subsequent interference with feeding. Add to the first link of belted 7.62mm ammunition a metal tab to assist in loading the belt into the M60 machine gun. These changes will increase the suitability of the M60 machine gun for assault fire use (Paragraph 2a (3), p. 55).

3. RECOMMENDATIONS

a. The Rifle Squad

It is recommended that the rifle squad be composed of a squad leader, two fire team leaders, and five riflemen armed with M14 rifles; one machine gunner armed with an M60 machine gun and M1911A1 pistol, a grenadier/assistant machine gunner and a grenadier armed with M79 grenade launchers and pistols. (Details of the recommended organization are shown in Annex A.)

b. The Rifle Platoon

It is recommended that:

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(1)   The platoon consist of a platoon headquarters and four identical rifle squads.

(2)   The platoon headquarters be composed of a platoon leader armed with a pistol, a platoon sergeant armed with an M79 grenade launcher and a pistol, and a radio operator/messenger armed with an M14 rifle. (See Annex A for details.)

c.   The Mechanized Rifle Platoon

It is recommended that the mechanized rifle platoon have an organization identical to that of the rifle platoon except that five drivers armed with M14 rifles, one assistant platoon sergeant armed with the M79 grenade launcher and pistol, and five armored personnel carriers should be added. (See Annex A, p. 70 , for details.)

d.   Grenade Launcher Ammunition

It is recommended that a cannister type round be developed for the M79 grenade launcher and that when it is developed the pistol be deleted from those personnel armed with the launcher.

Annex A

RECOMMENDED PLATOONS

FIGURE A-1
RECOMMENDED RIFLE PLATOON

PLATOON HEADQUARTERS	
Platoon Ldr	Pistol
Platoon Sgt	M79/P
Radio Opr/Msgr	M14

RECAPITULATION

Personnel	Off	EM
Plat Hqs	1	2
4 Rifle Sqds		44
	1	46

Weapons

Pistols	14
M14	33
M79	9
M60	4

1 Sqd Ldr	M14
2 Fire Team Ldrs	M14
1 Machine Gnr	M60/P
1 Grenadier/	
Asst Mach Gnr	M79/P
1 Grenadier	M79/P
5 Riflemen	M14

AMMUNITION CARRIED PER WEAPON

Weapon	Rounds
Pistol	21
M14	100
M60	300*
M79	27

* 100 Rounds on Gunner – 200 Rounds on Asst Gunner

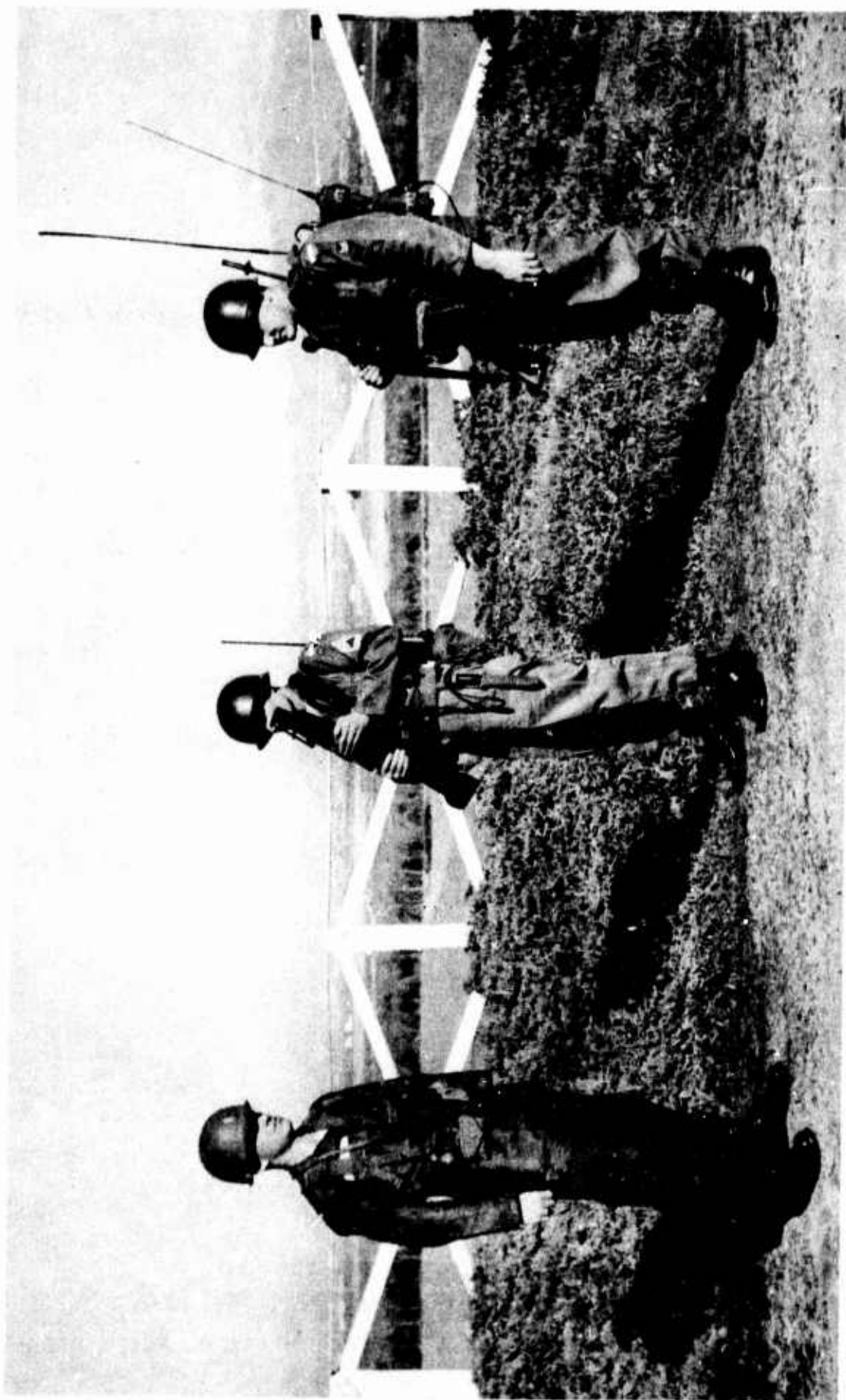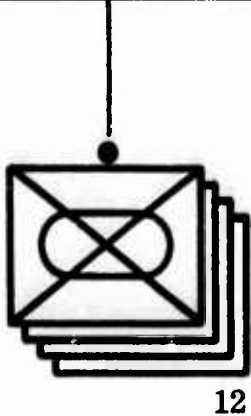FIGURE A-2   RIFLE PLATOON HEADQUARTERS

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FIGURE A-3 RIFLE SQUAD

ANNEX A

FIGURE A-4
RECOMMENDED MECHANIZED RIFLE PLATOON

PLATOON HEADQUARTERS	
Platoon Ldr	Pistol
Platoon Sgt	M79/P
Asst Plat Sgt	M79/P
Radio Opr/Msgr	M14
Driver	M14

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1 Sqd Ldr	M14
2 Fire Team Ldrs	M14
1 Machine Gnr	M60/P
1 Grenadier/ Asst Mach Gnr	M79/P
1 Grenadier	M79/P
5 Riflemen	M14
1 Driver	M14

RECAPITULATION

Personnel	Off	EM
Plat Hqs	1	4
4 Rifle Sqds		48
	1	52

Weapons

Pistols	15
M14	38
M79	10
M60	4

Vehicles

M113 APC	5

AMMUNITION CARRIED PER WEAPON

Weapon	Rounds
Pistol	21
M14	100
M60	300*
M79	27

* 100 Rounds on Gunner - 200 Rounds on Asst Gunner

Annex B

FIRING COURSES

FOR OFFICIAL USE ONLY

Numerals refer to lane numbers
Total number of hit recorders: 160
o E type
□ E type, electrically wired

13 M

200 M

400 M

FIRING LINE

50 M

FIGURE B-1   COURSE I, BASE OF FIRE

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ANNEX B

Numerals refer to lane numbers
Total number of hit recorders: 160
o E type
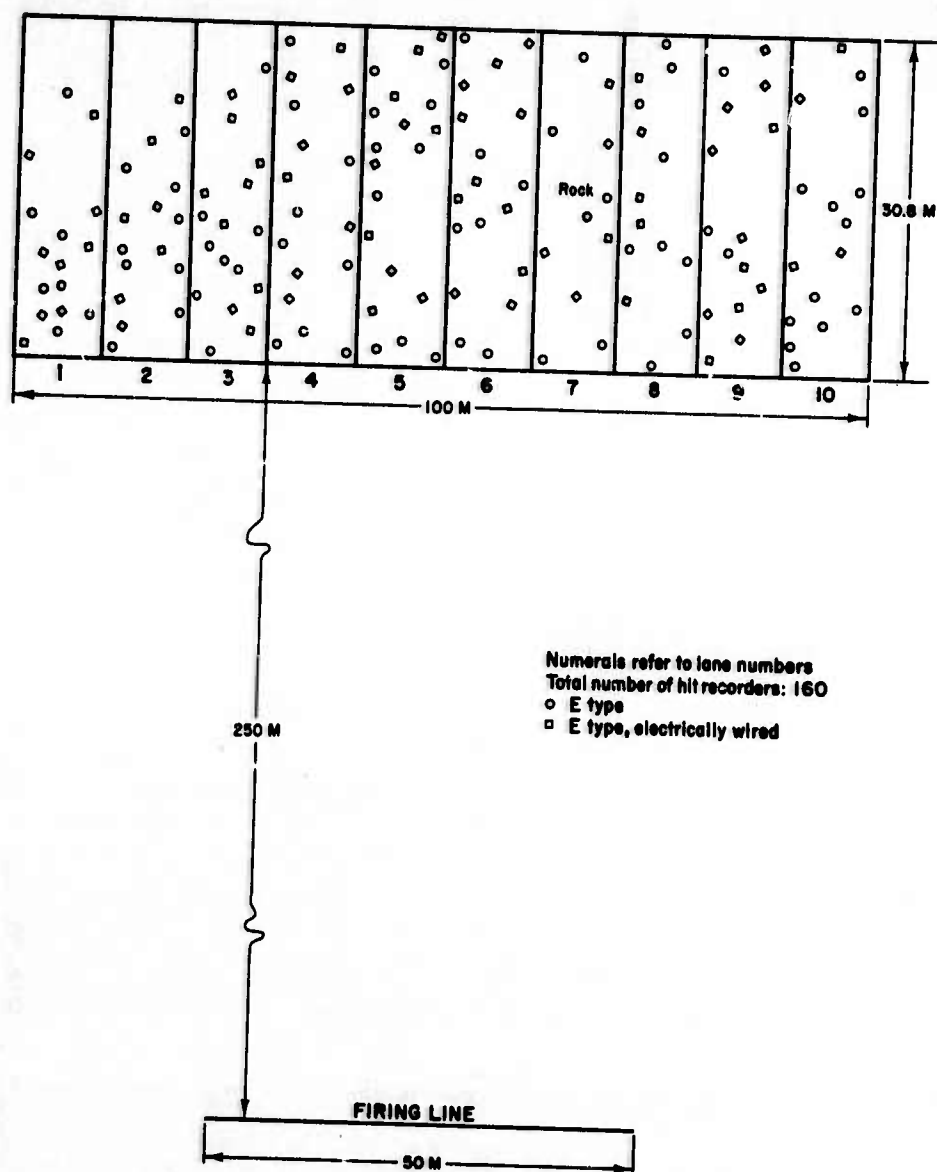□ E type, electrically wired
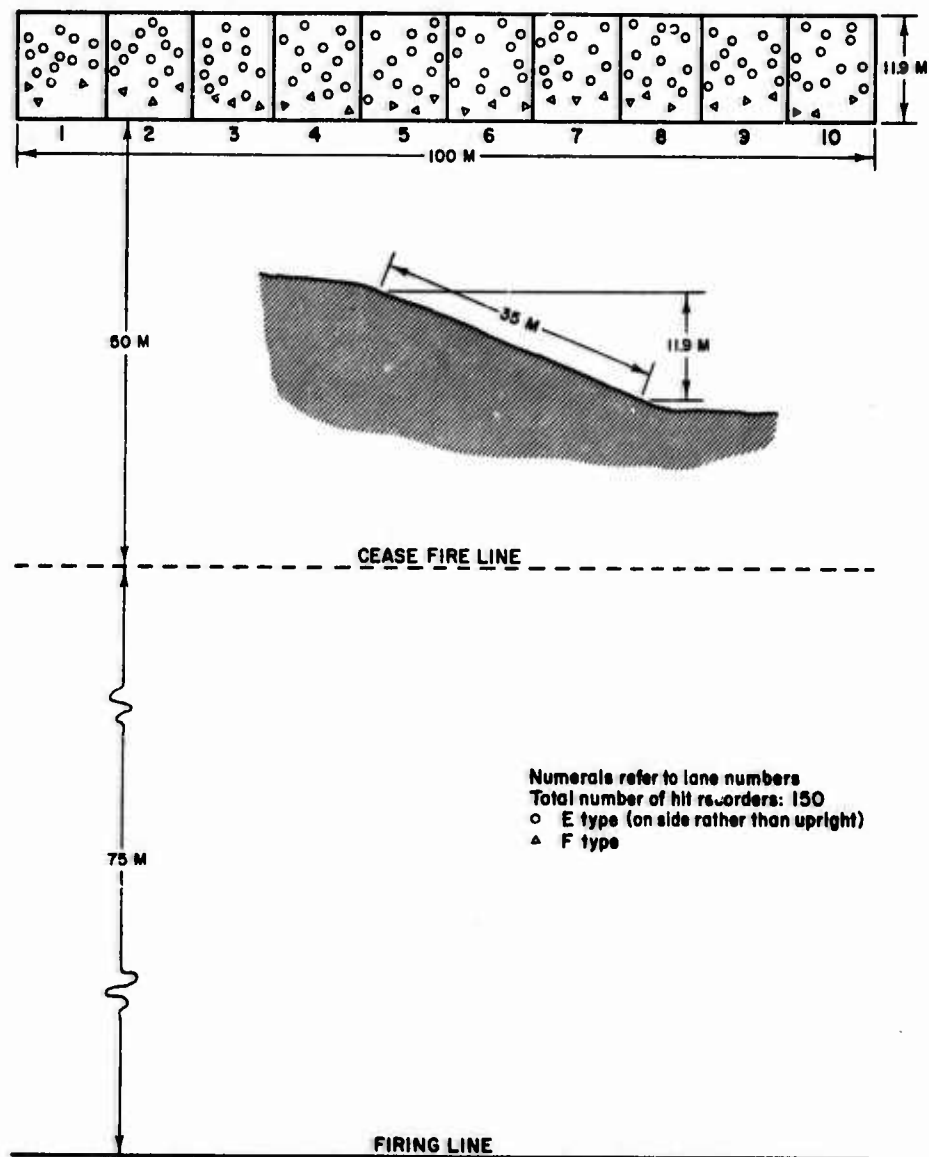
FIGURE B-2
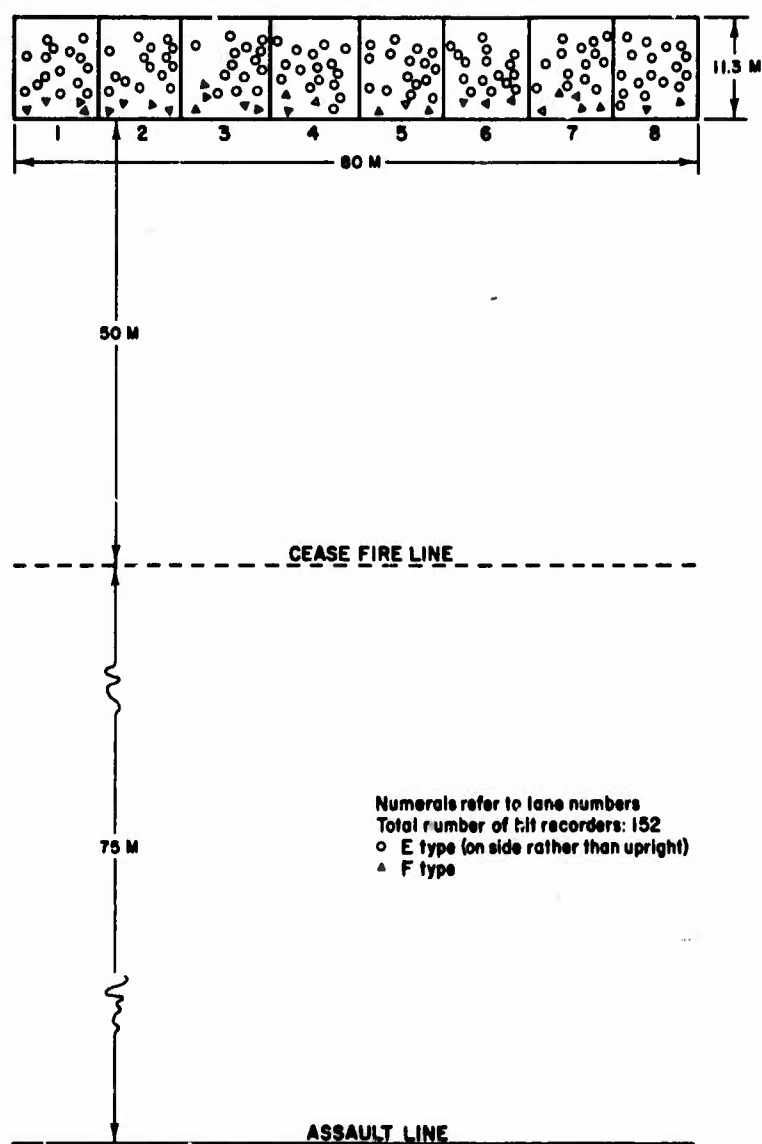**COURSE II, BASE OF FIRE**

FIGURE B-3
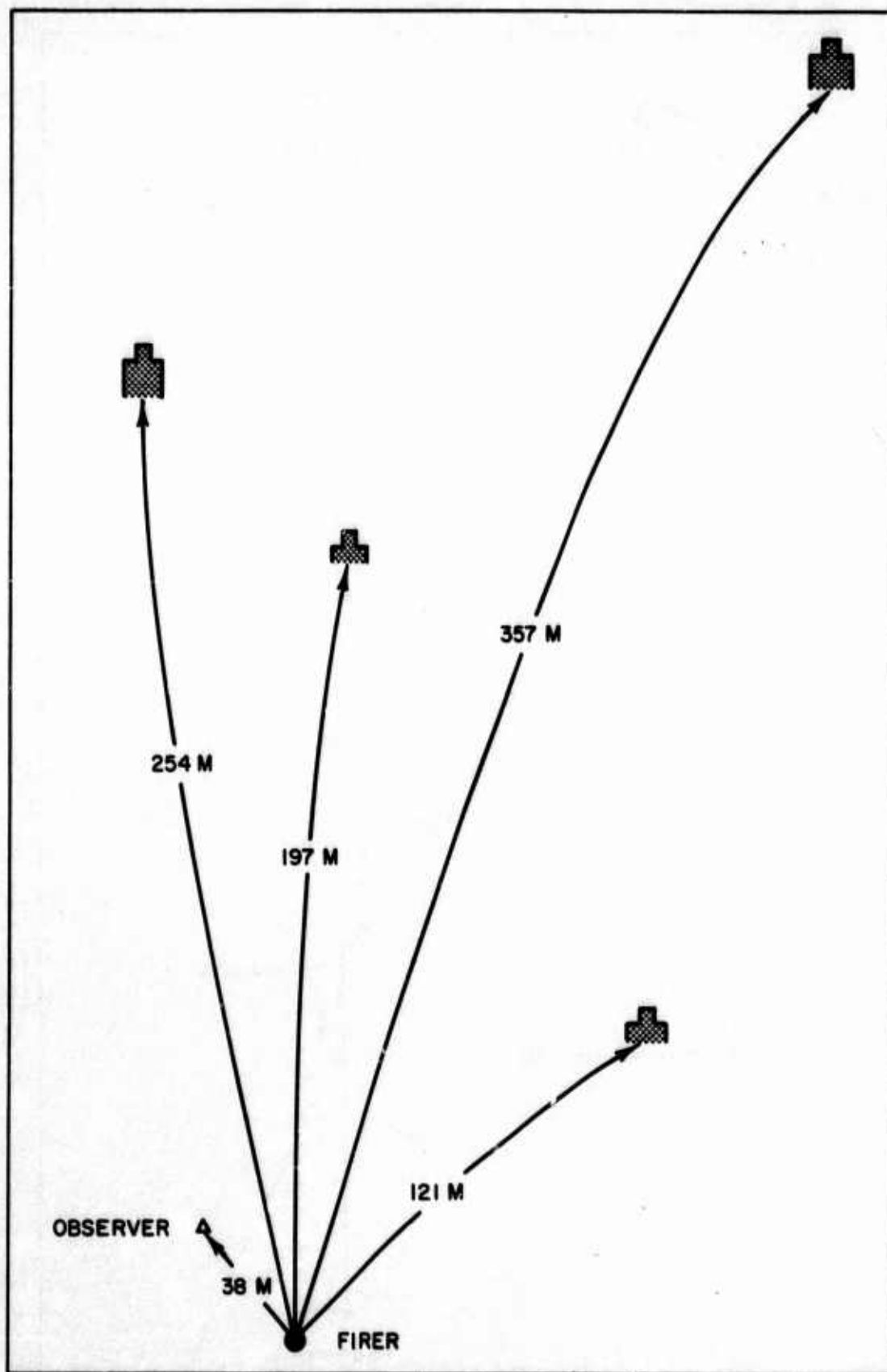COURSE III, ASSAULT

FIGURE B-4
COURSE IV, ASSAULT

FIGURE B-5
COURSE V M79 WITH AND WITHOUT OBSERVER

FIGURE B-6

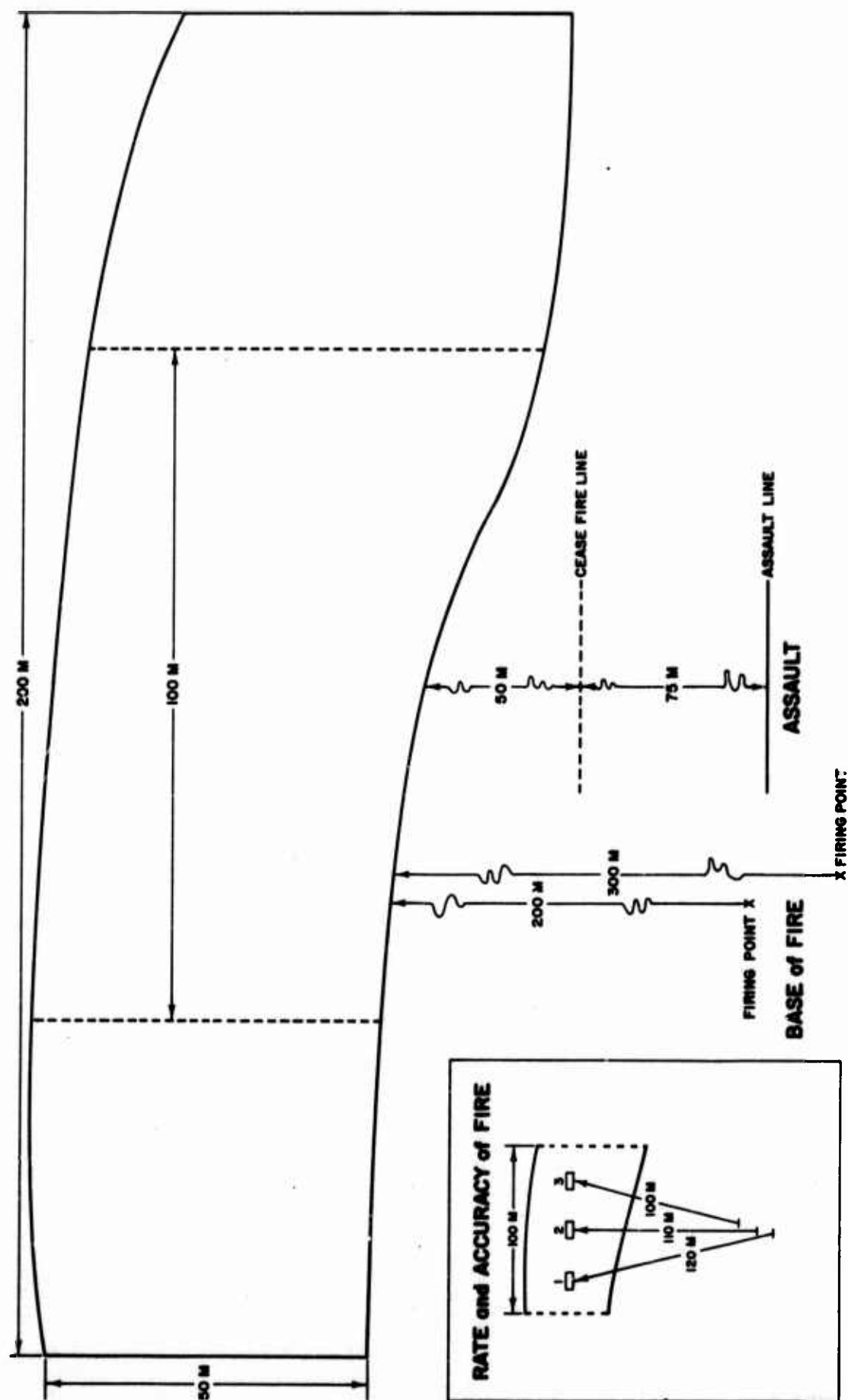**COURSE VI M79 IN WOODED AREA**

FIGURE B-7 COURSE VII, M-79

ANNEX B

FOR OFFICIAL USE ONLY

Annex C

STATISTICAL ANALYSIS

<u>Dependent Variables</u>

In the Rifle Platoon Firepower Experiment, the following dependent variables were considered:

1. Hits

2. Different targets hit

3. Hits per round fired

4. Different targets hit per round fired.

In the analysis, any one or combinations of these were examined as functions of the independent variable — the squad type or weapon configuration.

Total hits and different targets hit are self-explanatory measures. Hits per round fired, a ratio estimate, gives the actual probability of a hit; while different targets hit per round fired, also a ratio estimate, gives an indication of dispersion of hits. Sometimes the latter is referred to as "hit distribution." (The term distribution as used here bears no relation to same used in statistical terminology.)

<u>Test of Hypotheses</u>

To determine the validity of the split run procedure and to obtain estimates of meaningful differences in effectiveness, if any, between squad types, several hypotheses were tested.

The split run procedure consisted in separately employing M14 rifles and M60 machine guns, then synthetically combining the data from these separate runs into what would constitute a joint effort by both weapons. It must be realized that such pooling of data is justified only in situations where the effect due to an interaction among weapons is negligible or absent. That is to say, the procedure would be valid only under the assumption that the effects of both weapons on the target system are independent. A test procedure was devised to bear this out one way or another.

Statistically, under additivity, the observed yields (dependent measures) y_{ij} can be represented by the complete model

$$y_{ij} = \mu + r_i + m_j + (rm)_{ij} + \epsilon_{ij}. \tag{1}$$

ANNEX C

where μ = overall means

r_i = rifle effect

m_j = machine gun effect

$(rm)_{ij}$ = effect due to interaction

ϵ_{ij} = observational errors assumed to be uncorrelated with zero and variance σ^2.

Under the null hypothesis of zero interaction ($H_o:(rm)_{ij} = 0$), model (1) becomes

$$y_{ij} = \mu + r_i + m_j + \epsilon_{ij} . \tag{2}$$

Taking the difference of the contributions in fitting the complete and reduced models and expressing this difference as a ratio over the estimated experimental variance s^2 we obtain a valid test criterion for the above hypothesis. It appears, by examining the estimated ratios using all dependent variables, that only on Course III for squad organization CHARLIE is the rifle-machine gun interaction significantly different from zero*. No single explanation for this is available. It is believed the combination of multitude of extraneous uncontrollable variables is the main contributing factor for this phenomenon. Because of this interaction the subsequent discussion differentiates between Courses I, II, IV and Course III. That is to say, the split run data for BRAVO and CHARLIE squad organizations are used on Courses I, II, and IV, while on Course III the combined run data are used for the same squad organizations.

In examining the performance characteristics of A vs. B vs. C, the null hypothesis is formulated:

$$H_o: A = B = C.$$

On the basis of total hits and total targets hit on Courses I, II, and IV, the null hypothesis is rejected, and it is concluded that a real difference does exist between the three configurations. Rank ordering the squad types:

$$C > B > A.$$

This is to be expected since the number of rounds fired follows the same increasing sequence. (See Table C-1 below.)

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* Significance level of .05 is used throughout this discussion.

TABLE C-1

NUMBER OF ROUNDS FIRED, TOTAL HITS AND TARGETS HIT

Course	Rounds Fired			Total Hits			Tot Diff Tgts Hit		
	A	B	C	A	B	C	A	B	C
I	13,546	17,640	21,418	562	695	825	412	542	616
II	13,431	17,413	21,438	657	916	1,016	461	692	738
IV	10,617	14,522	18,240	1,432	1,942	2,016	866	1,189	1,292

Note: Figures are sum totals of 20 runs. Those shown for BRAVO and CHARLIE squads represent summed split run data.

If the same dependent measures are considered on a per-round-expended basis, the null hypothesis becomes

$$H_o: p_A = p_B = p_C \, ,$$

where p_A, p_B, and p_C are either hits per round fired or targets hit per round fired for squad organizations A, B, and C, respectively. Under H_o,

$$p_A = p_B = p_C = p \, ,$$

where

$$p = \frac{\text{Total hits (or targets hit)}}{\text{Total rounds fired}} \, .$$

On the base of fire Courses I and II, the null hypothesis is rejected and the conclusion made that at the .05 level no significant difference exists between A, B, and C. On assault Course IV, however, organization C deviates from A and B, being considerably lower. Table C-2 below bears this out.

TABLE C-2

HITS AND TARGETS HIT PER ROUND FIRED, COURSES I, II, IV

Course	Hits/Round Fired			Targets Hit/Round Fired		
	A	B	C	A	B	C
I	.0415	.0394	.0385	.0304	.0292	.0268
II	.0489	.0526	.0474	.0343	.0365	.0319
IV	.1349	.1337	.1105	.0773	.0796	.0705

Note: The figures shown for BRAVO and CHARLIE squads represent summed split run data.

On assault Course III, because of the interaction, the combined runs are used in testing the above hypothesis. Organization A (M14 rifles only) appears to be superior to squad organizations B and C (augmented with one and two machine guns respectively) in hits per round fired and targets hit per round fired. (See Table C-3.)

TABLE C-3

HITS AND TARGETS HIT PER ROUND FIRED, COURSE III

Course	Hits/Round Fired			Targets Hit/Round Fired		
	A	B	C	A	B	C
III	.1194	.1094	.0832	.0773	.0684	.0532

Note: Figures shown for BRAVO and CHARLIE squads use data from combined runs.

A table showing average hits and targets hit per run with standard deviations for ALFA, BRAVO, and CHARLIE squad organizations is appended to this discussion (Table C-6, p. 91).

To investigate the difference in effectiveness, if any, between one and two machine guns (B_{MG} vs. C_{MG}) in hits and targets hit per rounds fired, the following null hypothesis was formulated:

$$H_o : p_{B-MG} = p_{C-MG}.$$

The obvious alternative hypothesis was

$$H_a : p_{B-MG} \neq p_{C-MG}.$$

Under H_o,

$$p_{B-MG} = p_{C-MG} = p,$$

where

$$p = \frac{\text{total hits (or targets hit)}}{\text{total rounds fired}}.$$

The conclusion was that one machine gun yields more hits, and more targets hit, per round fired than two machine guns on all courses except Course I, where no statistical difference can be demonstrated. Table C-4 summarizes both dependent variables for all ranges.

TABLE C-4

HITS AND TARGETS HIT PER ROUND FIRED, ALL COURSES

Course	Hits/Round Fired		Targets Hit/Round Fired	
	B_{MG}	C_{MG}	B_{MG}	C_{MG}
I	.0344	.0338	.0304	.0248
II	.0544	.0415	.0417	.0311
III	.1156	.0847	.0889	.0601
IV	.0955	.0809	.0682	.0602

It is interesting to note that, although the ratio of rounds fired between one and two machine guns is approximately 1:2, the same ratio is not reflected in total hits and total targets hit for the machine guns.

Again, if it is of interest to consider hits and targets hit on a per run basis for the machine guns, see the appended table (Table C-8, p. 92) which lists averages and their respective standard deviations.

To investigate the uniformity of fire coverage over the area, it was desired to blanket the course with as many hit indicators as practicable. Each course was partitioned into 10-meter vertical lanes, each lane

containing an identical number of targets* systematically placed (terrain permitting) to ensure uniform target coverage. The following null hypothesis can now be set up:

$$H_o: L_1 = L_2 = \ldots\ldots = L_i \, , \, (i = 1, 2, \ldots\ldots)$$

where L_i are lane totals.

The test is, in fact, that there is no real difference between lanes versus the alternative that fire is more directive toward one lane than another. The analysis of variance was made with the following degrees of freedom breakdown:

Source	Degrees of Freedom
Between lanes	s - 1
Between runs/lanes	n - s
Total	n - 1

(n = sample size, s = lanes).

On Courses I, III, and IV, the results of this analysis indicate that, regardless of the dependent measure used, none of the three squad organizations fired uniformly over the area. In view of this, estimates are needed to determine the degree of deviation from uniformity in making objective comparisons between weapon mixes. These estimates are based on variance ratios from analysis of variance. In what follows each course is discussed separately. A table of estimates (Table C-5) follows the discussion.

1. Course I. No significant difference exists in deviation from uniformity between A, B, and C, using any of the four dependent measures. A appears to be slightly better than B or C. Most fire was concentrated on lanes 6 through 10, 16, and 20, by all squads.

2. Course II. No estimates could be made because of target placement. Indications were that most fire was received on lanes 6 through 9.

3. Course III. The A organization deviates from uniformity less than C or B, the latter being by far the worst. On this course lanes 2, 3, and 7 received most fire with all organizations.

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* On Course II uniform placement of targets was not practical. In view of this, the test of uniformity on this course is meaningless and only trends can be presented.

4.   Course IV.   Squad A was most uniform with B and C following in that respective order.   Lanes 3 through 5 received very little fire.

Before leaving the subject of fire dispersion, one can conclude that A organization, in general, approached a uniform distribution in all dependent variables to a greater extent than did B or C on all courses.   Squad C was better than B on Course III, the reverse being true on Course IV, while no meaningful difference between B and C was evident on Course I (see Table C-5, following).

Kymograph (Esterline-Angus)

To investigate the volume of hits, half of the targets on the two base of fire courses were instrumented to record hits on moving tape.   This tape for the full run cycle was graphically subdivided into 30-second intervals and the number of hits in each were counted.   The hypothesis was tested that hits were distributed uniformly with time, i.e., that the same number of hits were recorded in each of the 30-second intervals.   The results of the test indicate that null hypothesis had to be rejected on both base of fire courses.   All weapon organizations showed a lack of uniformity on a time basis.   There appeared to be a definite monotonic decreasing tendency of hits vs. time for all organizations.

TABLE C-5

SUMMARY OF ANALYSIS OF VARIANCE

Course	Hits			Targets Hit			Hits/Rd Fired			Tgts Hit/Rd Fired		
	A	B	C	A	B	C	A	B	C	A	B	C
I	3.76	4.27	4.28	3.69	3.88	3.89	4.19	4.25	4.26	3.64	3.90	3.93
III	2.28	6.60	4.98	2.85	7.60	5.66	2.36	5.90	4.77	2.88	7.28	5.44
IV	2.41	5.33	7.90	2.38	7.69	8.73	1.59	5.20	8.26	2.57	7.42	8.83

Note: Figures are variance ratios.

TABLE C-6

AVERAGE NUMBER OF HITS AND TARGETS HIT PER RUN

BASE OF FIRE COURSES I, II, AND ASSAULT COURSE IV

Course	Hits			Targets Hit		
	A	B	C	A	B	C
I	28.10 (8.39)	34.75 (10.99)	41.25(10.73)	20.60(5.23)	27.10(6.83)	30.80(4.97)
II	32.85 (12.05)	45.80 (8.41)	50.80 (12.77)	23.05(6.58)	34.60(8.69)	36.90(7.06)
IV	71.60 (20.18)	97.10 (23.10)	100.80 (17.25)	43.30(7.60)	59.45(8.27)	58.60(6.97)

Note: All averages are based on 20 runs. For BRAVO and CHARLIE squads split runs are used. The figures shown in parentheses are standard deviations.

TABLE C-7

AVERAGE NUMBER OF HITS AND TARGETS HIT PER RUN

ASSAULT FIRE COURSE III

Course	Hits			Targets Hit		
	A	B	C	A	B	C
III	61.40(17.58)	79.67(10.93)	74.33(6.16)	39.75(9.28)	49.83(6.64)	47.50(2.22)

Note: Average for ALFA squad is based on 20 runs, while those for BRAVO and CHARLIE use 6 combined runs. The figures shown in the parentheses are standard deviations.

TABLE C-8

AVERAGE NUMBER OF HITS AND TARGETS HIT PER RUN

FOR ONE AND TWO MACHINE GUNS

Course	Hits		Targets Hit	
	B_{MG}	C_{MG}	B_{MG}	C_{MG}
I	10.25(4.06)	19.80(6.93)	9.05(3.50)	14.50(3.93)
II	15.85(4.19)	24.50(7.73)	12.15(3.24)	18.35(5.04)
III	22.75(5.25)	32.75(8.13)	17.50(3.55)	23.25(4.82)
IV	19.05(6.27)	32.10(7.15)	13.60(3.76)	23.90(4.00)

Note: Averages are based on 20 machine gun runs.
         Numbers in parentheses are standard deviations.

Annex D

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An experiment was conducted under simulated combat conditions to determine the best distribution of weapons currently available to the rifle platoon. Three rifle squad organizations were used with different weapon mixes of the M14 rifle, M14 modified rifle, M60 machinegun, and M79 grenade launcher. Rifles and machineguns were first fired at different times, one run at a time, and results in terms of volume, accuracy and distribution of fire were recorded for each. After that, both weapons were fired at the same time in several control runs. This was to account for possible interactions that split runs might not show. The M79 grenade launcher was evaluated primarily by measuring the points of bursts from targets, rather than the effects of rounds on targets. These exercises led to specific recommendations regarding the composition and organization of rifle and mechanized rifle squads and platoons. (U).

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	ROLE	WT	ROLE	WT	ROLE	WT
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